Are Consumers Myopic?

Evidence from Handset and Mobile Services Choices[*]

Ambre Elsas-Nicolle[†]

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Abstract

In this paper, I estimate discrete choice models for the joint selection of handsets and mobile tariffs, using data on 10,738 subscribers of a European mobile telecommunications operator observed between April 2011 and December 2014. The estimates are used to compute an attention weight on future recurring tariff payments, measured relative to the upfront handset cost. I interpret this weight as a "revealed-choice" measure of consumer myopia. The results show that consumers substantially underweight future costs on average, with heterogeneity across consumer groups and, more importantly, over time. The average attention weight increases sharply during the period studied, coinciding with the diffusion of SIM-only tariffs and the entry of a new competitor. These market changes affected prices and variety, but also increased the salience and transparency of total contract costs. Counterfactual simulations show that consumer welfare gains come from both the decline in tariff prices and the availability of SIM-only offers. The price decline accounts for a large share of the gains, while SIM-only tariffs provide additional welfare gains by expanding the choice set. Comparing the estimated attention weights with a full-attention benchmark further shows that consumer underattention shapes predicted choices.

Keywords: Consumer choices; Consumer attention; Price transparency; Competition; Mobile telecommunications.

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[†]Mines Paris, PSL University, Centre for Economics and Public Decisions (CEDP), i3 UMR9217 CNRS, 75006 Paris, France. Email: ambre.elsas-nicolle@minesparis.psl.eu

1 Introduction

Consumers facing a choice that involves an intertemporal dimension may undervalue or, conversely, overvalue future costs and benefits from a decision. Undervaluation of future costs has been documented in choices of air conditioners (Hausman, 1979), heating systems (Dubin and McFadden, 1984), cars (Allcott and Wozny, 2014; Busse et al., 2013; Dreyfus and Viscusi, 1995; Grigolon et al., 2018), and more recently for photovoltaic systems (De Groote and Verboven, 2019). Assessing how consumers weigh future costs is crucial to better understand consumption choices and to help policymakers design consumer-protection policies, or programs promoting the adoption of new durable technologies.

In this paper, I use the term myopia in a "revealed-choice" sense: consumers are myopic when future recurring charges receive less weight than the upfront handset payment in the subscription decision. The measure of interest in this study is, therefore, an *attention weight* on future payments, not a structural estimate of time preferences.

Although mobile tariffs have traditionally tied consumers to a provider for an extended period of time and included a mobile handset at a one-off price, intertemporal choices in the mobile telecommunications market have been little studied. Consumers typically choose among a wide range of options, involving handset models, mobile-service attributes such as voice, SMS, and data allowances, and different pricing schemes. The latter are differentiated by the amount of upfront payments (paid by the consumer at the time of subscription) and subsequent recurring ones, paid over the duration of the contract. The introduction and diffusion of SIM-only tariffs, i.e., mobile plans that are not bundled with handsets, expanded the choice set considered by individuals, but more importantly, increased transparency regarding the trade-off between current and future expenses. By separating the handset purchase from the service contract, SIM-only tariffs make monthly fees more directly comparable across offers and make the implicit cost of handset subsidies more transparent, thereby plausibly changing the attention consumers paid to future payments. In the market I study, incumbent operators launched low-cost (SIM-only) brands in October 2011, shortly before the entry of a new mobile network operator in January 2012.

I study how consumers trade off upfront handset payments against recurring tariff payments, and how the weight placed on the latter varies across consumers and over time. To do so, I develop a discrete choice model of demand for handsets and mobile tariffs. I use a unique dataset of 10,738 subscribers to a large European telecommunications operator who selected a handset and a tariff between April 2011 and December 2014.[1] In my setting, consumers can either choose a contract with a subsidized handset, which involves a lower upfront handset price but higher monthly recurring charges, or choose a SIM-only contract, which is not bundled with a handset, and purchase the handset separately at full price from any retailer.

I use the estimates from the demand model to compute an attention weight on future recurring charges. This weight measures the extent to which recurring tariff payments affect choices relative to upfront handset payments. The empirical specification is a conditional logit model in which alternatives are handset-tariff combinations. I construct sampled choice sets, compute recurring payments based on assumptions about the interest rate and the relevant payment horizon, and use the tariff list price as the measure of monthly charges.[2]

Estimation results suggest that consumers underweight future costs on average, with important heterogeneity across consumers. In particular, I find significant differences across age groups, but not between genders. More importantly, the "underweighting" of future charges decreases over time, coinciding with the launch and diffusion of SIM-only tariffs. One possible interpretation is that the increase in the attention weight is mechanically driven by the growing share of consumers choosing SIM-only contracts. I show, however, that this increase is not merely a composition effect: attention to future costs rises not only among consumers choosing SIM-only tariffs, but also among those choosing tariffs bundled with handsets. I therefore interpret the evolution of the attention weight as reflecting broader changes in the market environment following the launch of low-cost SIM-only offers and the subsequent entry of a new mobile network operator, including changes in prices, tariff variety, and the salience of future

[1] The data are confidential, so the country and operators are anonymized throughout the paper. Therefore, I describe the institutional setting using market-level information and report representativeness checks in Figure OA.1 and Table OA.1 (presented in the Online Appendix), based on data from International Data Corporation (IDC), a market research company that provides information on technology and telecommunications markets.

[2] I discuss these assumptions when introducing the model in Section 5 and assess their importance in Section 8.2. In particular, I examine the sensitivity of the results to alternative assumptions about interest rates, payment horizons, samples, product fixed effects, substitution patterns, and choice set construction.

recurring payments.

I conduct several counterfactual analyses to assess how choices and consumer welfare are affected by declining tariff prices, the introduction of SIM-only tariffs, and the attention weight itself. The simulations suggest that both the tariff-price decline that followed the launch of low-cost SIM-only brands and the entry of the new operator, and the availability of SIM-only tariffs, improved consumers' choice environment. The price decline accounts for the larger share of the simulated welfare gains, while SIM-only tariffs provide additional gains by expanding the choice set and separating handset acquisition from mobile-service subscription. I also compare predicted choices under the estimated attention weights with a full-attention benchmark in which recurring tariff payments receive the same weight as upfront handset payments. The results highlight that consumer underattention affects the composition of predicted choices: under full attention, consumers are more likely to choose cheaper tariffs, shorter commitments, and, when available, SIM-only offers.

This paper contributes to a better understanding of consumers' intertemporal decision-making in three ways. First, it uses individual-level choices to estimate heterogeneity in the attention paid to future recurring payments, both across consumers and over time. Second, it quantifies this phenomenon in mobile telecommunications markets, which have been identified as particularly prone to consumer detriment (European Commission, 2017). Finally, because I observe several cohorts of subscribers entering the market at different points in time, I can assess how changes in the competitive environment, tariff variety, and price transparency are associated with changes in the attention paid to future recurring charges. The results suggest that competition can affect consumers not only through lower prices but also through how firms frame, bundle, and unbundle product components or attributes.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the industry and the market developments during the sample period. Section 4 presents the data and Section 5 introduces the empirical model. Section 6 discusses the main empirical results. Section 7 turns to the counterfactual analyses and their results. Section 8 reports additional analyses and robustness tests. Finally, Section 9 concludes.[3]

[3]Figures and tables labeled "A." appear in the Appendix; those labeled "OA." appear in the Online Appendix.

2 Related literature

This paper builds on the literature on consumers' intertemporal choices, namely choices that involve a trade-off between costs and benefits at different points in time. Consumers face such decisions when they choose products that combine an upfront payment with future costs or benefits, from durable goods with operating costs to subscription contracts with recurring charges. In this paper, I focus on a static subscription decision in which consumers choose among currently available handsets and tariffs.[4]

The theory of discounted utility is the most widely used framework for analyzing intertemporal choices (Ericson and Laibson, 2019). It highlights the existence of a parameter (the *discount factor*) that impacts the utility derived from future expenses or earnings flows. Evidence of undervaluation of future expenses has been documented across various industries, but predominantly in energy markets, where consumers face a trade-off between capital and operating costs. Hausman (1979) computes an implicit discount rate for air conditioner purchases and finds an average rate of 20%, decreasing with the household's income level. Dubin and McFadden (1984) use a similar approach for the choice of heating and cooling systems and found comparable values.

My empirical approach is closest to studies that estimate the weight consumers place on future costs in observed choices, rather than a "structural" discount factor. In particular, I distinguish the market interest rate used to compute the present value of future payments from the weight consumers appear to place on those payments in their decisions. This weight is often referred to as an *attention weight* and interpreted as a measure of consumer myopia. Such attention weights have been estimated for car purchases in the United States (Allcott and Wozny, 2014; Busse et al., 2013) and Europe (Grigolon et al., 2018). These studies generally find evidence that consumers undervalue future costs, although the estimated degree of undervaluation is modest.

[4]The empirical analysis is conditional on consumers having decided to subscribe to a mobile contract. I therefore model the subscription choice among currently available handset-tariff combinations and abstract from the option to wait. Dynamic considerations may be more important in settings where consumers choose when to adopt or replace a durable good, as prices decline and quality improves over time. See, for example, Bronnenberg et al. (2008) and Dubé et al. (2014) on methodological issues; and Gowrisankaran and Rysman (2012), De Groote and Verboven (2019), and Daljord (2022) for applications.

In a different market, and using a dynamic approach, De Groote and Verboven (2019) study consumers' undervaluation of future benefits in the adoption of photovoltaic systems. They find that households substantially discount future payoffs, which made a government subsidization program based on future production subsidies more costly than an alternative policy based on upfront investment subsidies would have been. This evidence illustrates how consumers' valuation of future costs and benefits can affect the efficiency of public policy. Similarly, Grigolon et al. (2018) show that, despite consumers' undervaluation of future fuel costs, fuel taxes are more effective than taxes on less fuel-efficient cars because of heterogeneity in consumer mileage. Beyond policy design, consumers' undervaluation of future expenses, or myopia, can also affect the functioning of markets more broadly. It may shape competition between firms (Gabaix and Laibson, 2006) and has been identified by regulators as a source of consumer detriment (e.g., European Commission, 2007).

A related body of work studies consumers' intertemporal choices and the mechanisms behind present-biased behavior. Theoretical models of present bias and quasi-hyperbolic discounting formalize the idea that consumers may place disproportionate weight on immediate costs and benefits relative to future ones (Harris and Laibson, 2001; O'Donoghue and Rabin, 1999). Other explanations from related research fields emphasize how consumers perceive outcomes occurring at different points in time (Loewenstein, 1996; Zauberman and Lynch, 2005), how they perceive the relevant time horizon (Zauberman et al., 2009), and how intertemporal choices are framed (Loewenstein, 1988).[5] These mechanisms appear relevant to this paper because the introduction of SIM-only tariffs changed not only the prices consumers faced, but also how current and future payments were presented. In particular, by separating the handset purchase from the mobile-service contract, SIM-only tariffs likely made the intertemporal trade-off more transparent and easier to evaluate.

The mobile telecommunications market is a natural setting for studying attention to future expenses, yet it has been studied only to a limited extent, especially in relation to handset costs. This market has two additional features that make it a particularly useful empirical setting.

[5] See the survey by Soman et al. (2005) for additional discussion of present-biased behavior. See also Loewenstein and Thaler (1989) and Thaler (1981), who discuss several "anomalies" observed in intertemporal choices.

On the one hand, consumers make choices over a shorter horizon than in many durable-goods settings, such as cars or photovoltaic systems. On the other hand, mobile telecommunications markets have been identified as particularly prone to consumer detriment by European Commission (2017), and consumer myopia is listed as one possible source of such detriment (European Commission, 2007).[6]

Existing work on mobile telecommunications has mostly studied tariff choices, usage decisions, nonlinear pricing, switching, and learning, rather than the intertemporal trade-off created by handset-tariff bundling. Prior studies have documented biases in tariff choice (Lambrecht et al., 2007; Lambrecht and Skiera, 2006; Train et al., 1987), price elasticities (Pereira and Ribeiro, 2011), willingness to pay for service attributes (Grzybowski and Liang, 2015; Rosston et al., 2010), switching costs (Grzybowski, 2008), and consumer learning (Genakos et al., 2023; Miravete, 2003). A particularly related contribution is Yao et al. (2012), who use field data from a mobile-phone service provider to estimate consumers' discount factors from usage decisions under linear and three-part tariffs. Their paper shows that intertemporal trade-offs matter in mobile-service consumption. Similarly, Grubb and Osborne (2015) estimate a model of cellular plan choice, usage, and learning, and show that consumers are inattentive to past usage and overconfident about future consumption, exposing them to bill shock. The literature on handset choices is less abundant, but covers issues such as switching costs between phones (Park and Koo, 2016), switching costs between brands and operating systems (Grzybowski and Nicolle, 2021), and patent valuation (Hiller et al., 2018). Papers that study the simultaneous choice of mobile service and handset are relatively scarce. They focus, for example, on estimating switching costs between service providers (Cullen and Shcherbakov, 2010), measuring network effects between operating systems (Liu and Luo, 2023), or studying exclusivities between smartphone manufacturers and mobile operators (Sinkinson, 2014). Relative to these papers, my focus is not on tariff choice, handset demand, switching, or platform competition *per se*, but on the intertemporal trade-off created by the joint choice of a handset and a tariff.

This paper also connects to a broader literature on complex products, which shows that

[6]The role of handset-tariff bundling has also been discussed by regulators and international institutions (see, for example, OECD, 2013).

consumers may not fully account for cost components that are difficult to observe, predict, or compare. In health insurance, Brown and Jeon (2024) develop and estimate a model in which consumers endogenously choose how much information to acquire about difficult-to-observe plan characteristics, such as out-of-pocket costs. Although their empirical setting differs from mine, the mechanism is closely related. In both settings, consumers face products with several price components, some of which are more salient than others. Changes in transparency or product complexity can therefore affect both choices and welfare. In a mobile telecommunications setting, Elsas-Nicolle et al. (2025) show that handset-tariff bundling can facilitate strategic obfuscation by making offers less transparent and harder to compare, allowing operators to sustain higher prices. This paper provides complementary demand-side evidence by estimating how consumers weigh recurring tariff payments relative to upfront handset payments when choosing between bundled handset-tariff contracts and SIM-only alternatives.

Finally, this paper relates to the large literature on the impact of competition on mobile service prices and variety (e.g., Bourreau et al., 2021; Genakos et al., 2018). In particular, Bourreau et al. (2021) show that the entry of a new operator in the French market benefited consumers through an increase in tariff variety, partly related to the introduction of *fighting brands* by incumbent firms. Their data document demand for all operators and include both post-paid and prepaid tariffs, but are aggregated at the geographical-area level and contain no information on the handsets selected by consumers. In contrast, the data used in this paper are at the individual level and contain detailed information on available and selected tariffs and handsets. This allows me to provide complementary evidence on how a similar structural change, namely the entry of a new competitor, affected consumers' valuation of future expenses.

Overall, the paper combines elements of the intertemporal-choice literature with prior work on competition in mobile telecommunications markets. Extending the approach of Allcott and Wozny (2014), I allow the attention weight on future costs to vary across consumers and over time, and relate its evolution to changes in tariff prices, product variety, and price transparency.

3 Industry background

Mobile handsets have been bundled with mobile tariffs since the early stages of the industry, often with a long-term commitment for consumers, typically 24 months. This bundling strategy, which involves a *handset subsidy*, has been widely used by mobile operators to facilitate the take-up of mobile services (Barros, 2006; Tallberg et al., 2007), but also as a competitive tool (Choi et al., 2001).[7] SIM-only tariffs, i.e., mobile plans that are not bundled with a handset and therefore do not involve a handset subsidy, were introduced by operators for several reasons: in response to competitive pressure from new entrants, as in the United Kingdom or France; to reduce operational costs, as in Spain; or to serve niche segments, such as commitment-averse or highly price-sensitive consumers. These tariffs also expand consumers' handset choice. Consumers may prefer devices from marginal brands that were traditionally absent from operators' catalogs, or may choose to purchase refurbished or second-hand phones. In addition, handsets purchased directly from manufacturers' stores, such as Apple or Samsung stores, often come with additional services that some consumers may value.

The emergence of SIM-only tariffs also contributed to the development of alternative handset-financing schemes, such as installment plans, interest-free credit offered by operators, and leasing deals. Some market analysts have argued that these tariffs affected the handset replacement cycle. In many countries, replacement cycles used to closely follow the commitment period associated with mobile contracts, but they tended to lengthen after 2013, coinciding with the decline of "mass" handset subsidization.[8] Finally, regulation of mobile services also played a role in the changes observed in the market. Apart from bans on handset subsidies in Belgium (1991-2010), Finland (1996-2006), and Korea (2000-2006), policymakers aimed to reduce consumer lock-in by imposing rules on early-termination fees or contract length. Some national regulators also encouraged, or required, operators to unbundle services and handsets, or to provide more transparent information by displaying separate payments for the mobile service and the repayment of the handset (OECD, 2013).

[7] A detailed description of these practices across countries and over time is provided by OECD (2013).

[8] See the report *International Comparisons: The Handset Replacement Cycle* by Recon Analytics and http://reconanalytics.com/2015/02/2014-us-mobile-phone-sales-fall-by-15-and-handset-replacement-cycle-lengthens-to-historic-high/.

The empirical setting of this paper is a European mobile telecommunications market.[9] In this market, SIM-only tariffs became widely available during the period covered by the data, which allows me to compare consumers' choices, prices, and product variety before and after this change. The data also cover the commercial launch of 4G services by the four main mobile network operators (MNOs).[10] Figure A.1, in the Appendix, summarizes the main events that occurred between 2009 and 2014. The main market shock is the entry of a new mobile operator in January 2012. As part of the licensing process required to enter the market, the entrant announced that it would offer only SIM-only tariffs, at particularly attractive prices. Incumbent operators anticipated this entry and simultaneously launched their low-cost brands in October 2011. Although a few SIM-only tariffs were already available before then, this episode initiated their broader diffusion. Consistent with these market events, Figure A.2 shows that SIM-only tariffs became increasingly prominent after October 2011.

Figure 1 reports three market-level indicators over the period.[11] First, it shows the evolution of the Herfindahl-Hirschman Index (HHI), which captures market concentration among mobile network operators.[12] Second, it reports the national price index for post-paid mobile services. Third, it shows the share of free-of-commitment consumers, an indicator used by the national regulator to measure market fluidity.[13] The figure shows a sharp decline in both prices and market concentration. The post-paid price index falls from about 100 at the beginning of 2011

[9] Because the individual-level data were provided under a confidentiality agreement, I cannot disclose the identity of the country, the focal operator, or its competitors. I therefore refer to operators using anonymized labels. This limits the amount of institutional detail I can provide, but the key market events can be described precisely: the launch of low-cost SIM-only brands by incumbent operators, the entry of a new mobile network operator, and the subsequent launch of 4G services. I complement the operator-level data with anonymized market-level indicators from the national regulator and industry sources (See Figure 1), and provide representativeness checks in the Online Appendix (See Figure OA.1 and Table OA.1).

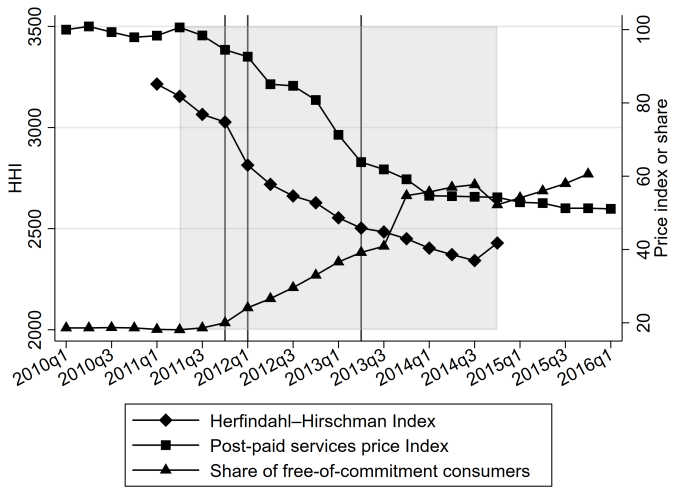
[10] 4G licenses were awarded in December 2011 and January 2012.

[11] These market-level indicators focus on MNOs, consistent with the empirical setting of the paper. Mobile Virtual Network Operators (MVNOs) and prepaid plans are part of the broader mobile market, but they are less directly related to the trade-off studied here between upfront handset payments and future recurring charges. Prepaid plans are typically not associated with long-term commitment or handset subsidies, while MVNOs were mainly active in niche segments. Statistics from the national regulator indicate that MVNO market shares increased before the entry period but remained relatively stable afterward, at around 10-11% of the market. The regulator also reports that prepaid cards declined after entry, while no-commitment post-paid offers expanded. I therefore interpret the main market shock studied in the paper as the diffusion of post-paid SIM-only and no-commitment tariffs among the main network operators, rather than as a shift driven by MVNOs or prepaid plans.

[12] The HHI is computed by summing the squared quarterly market shares of each MNO.

[13] Free-of-commitment consumers are those whose commitment period has ended or who are not tied to any commitment period, a category that typically includes SIM-only subscribers.

Figure 1: HHI, prices and free-of-commitment consumers



Notes: The figure reports market-level trends for mobile network operators. The grey area marks the period covered by the individual-level data used in the paper. The three vertical lines mark, respectively, the launch of low-cost SIM-only brands by incumbent operators, the entry of the new mobile network operator, and the introduction of 4G tariffs. Sources: Own computation based on data from the national regulator and Yankee Group.

to about 55 by the end of 2014, where it stabilizes.[14] Over the same period, the HHI declines from about 3,200 to about 2,400.[15] The figure also shows a clear increase in the share of free-of-commitment consumers after the third quarter of 2011, which is consistent with the diffusion of SIM-only, which are often free-of-commitment post-paid offers.[16]

Figure A.3 provides complementary descriptive evidence that these market events were accompanied by increased public interest in tariff prices, SIM-only offers, and handset subsidies. The figure reports Google Trends search intensity for anonymized search terms related to these topics. Google Trends reports a normalized index of relative search activity, scaled from 0 to 100 within the selected country and period, where 100 corresponds to the peak search intensity observed in the data.[17] Search interest fluctuates over time, but clear spikes appear around the

[14]The price index is normalized to 100 in January 2010.

[15]Using market shares expressed from 0 to 100, the HHI ranges from close to zero under perfect competition to 10,000 under monopoly.

[16]The number of SIM-only subscribers is unfortunately not available at the country level. In the next section, I report the share of consumers choosing SIM-only tariffs in my sample.

[17]Google Trends data have been used in economics and finance as high-frequency measures of public interest, information search, or attention; see, for example, Da et al. (2011) and Brodeur et al. (2021).

launch of low-cost SIM-only offers and the entry of the new operator, especially for searches related to "tariff prices" and "tariffs without handsets". These search volumes should not be interpreted as a direct measure of consumers' attention in my sample. Rather, it suggests that the market shock was salient at the national level and that consumers were increasingly exposed to information about the pricing dimensions that are central to the paper: recurring charges, SIM-only tariffs, and the implicit cost of handset subsidies.

4 Data

The data were obtained from a single European mobile operator and cover consumers observed between April 2011 and December 2014. They were made available under a confidentiality agreement that prevents me from disclosing the identity of the operator or the country.

Datasets The original data consist of a panel of 118,231 consumers with post-paid contracts, from which I initially identify 20,614 new subscribers. The data include information on subscriber characteristics, namely age, gender, and municipality of residence, as well as the identifier of the selected tariff and the brand and model of the handset used. Because this paper focuses on consumers' initial subscription choice, I only keep the first observation for each individual, so that the dataset becomes a cross-section.

After restricting the sample to individuals aged between 18 and 100, the data contain 20,277 observations. I also drop 12 subscribers for whom information on the municipality of residence is missing. Using individuals' postcodes, I complement the data with publicly available municipality-level information on income, population density, and unemployment rate. I then merge the tariff identifier observed in the subscriber data with the catalog of tariff characteristics provided by the operator. This dataset contains information on call and data allowances, contract length, and whether the tariff includes a handset subsidy option. A small number of tariffs cannot be matched to catalog information and are therefore dropped. After this step, the sample consists of 19,222 individuals.

I then merge the handsets observed in the data with a list of quarterly handset prices. About

half of these prices were provided by the operator, while the remaining were collected through web scraping[18] or obtained from the market-research firm International Data Corporation (IDC). I am able to match handset prices for 80.8% of the sample, leaving 15,540 observations. To compute the exact amount of handset subsidy obtained by each consumer, I use an additional catalog provided by the operator. This catalog records the subsidy associated with each handset model over time. Unsurprisingly, the subsidy is larger for more expensive tariffs.[19] I drop consumers who selected a tariff with a handset subsidy when the corresponding handset list price is unavailable. This step removes a non-negligible number of observations, but it is necessary to ensure that the prices used in the demand model are correctly measured.

Finally, I merge the handsets with a list of characteristics scraped from `GSMArena.com`. This source provides public information on handset characteristics, such as dimensions, operating system, battery life, and year of release. The final sample consists of 10,738 individuals.

Single-operator data and representativeness The single-operator nature of the data has two implications for the scope and interpretation of the analysis. First, the data come from a single operator. The analysis should therefore be interpreted as describing the choices of new subscribers to this operator, rather than choices in the entire mobile market. Second, because I do not observe the individual-level choice sets offered by rival operators, I cannot explicitly model the outside option of subscribing to another provider. This limitation may be particularly relevant around the entry of the new operator, when rival offers are likely to have become more attractive.

To assess how restrictive the single-operator setting is along observable dimensions, I use market-level data from IDC. Figure OA.1, in the Online Appendix, compares average tariff prices across the focal operator and other mobile network operators. The figure shows that prices are relatively comparable across the established operators (MNO 1, MNO 2, and MNO 3)

[18] For handsets not sold by the operator, I collected release prices from an independent website that aggregates handset characteristics and prices. I consider these prices valid for the six months following the release date. After this period, the price of a given handset is treated as missing.

[19] For example, in December 2014, Apple's iPhone 4S was sold at 492 euros with a SIM-only contract, 370 euros with a tariff above 20 euros per month, 340 euros with a tariff above 30 euros, 239 euros with a tariff above 43 euros, 99 euros with a tariff above 55 euros, and 49.9 euros with a tariff above 90 euros.

over the period, although differences between their main-brand prices increase somewhat after 2013. The prices of the low-cost brands remain close across both levels and trends over the period, while the entrant, MNO 4, is clearly positioned at lower prices. Thus, although the entrant follows a distinct pricing strategy, the focal operator's price path is broadly comparable to that of the other incumbent operators, both for the main brand and for the low-cost brand. This is important for interpreting the paper's findings, because the key market changes studied here (i.e., the diffusion of SIM-only tariffs and the decline in prices) were not specific to the focal operator but occurred across the main established operators.

I also compare the handsets observed in the estimation sample with market-level handset information, also from IDC. Table OA.1 shows that the handset sample used in the paper covers a similar range of prices and technical characteristics to the IDC sample. Minor differences remain: handsets in the estimation sample are somewhat more expensive on average, slightly older, and have a somewhat different brand composition.

Overall, these comparisons with IDC data do not eliminate the limitations of using single-operator data, but they support the view that the focal operator and the products observed in the sample are broadly representative of the market along the observable dimensions that are most relevant for the analysis: tariff prices, SIM-only availability, handset prices, and handset characteristics.

Descriptive statistics Table 1 provides an overview of the main variables included in the dataset. The average consumer is 43 years old, and 51% of consumers are women. The average monthly tariff price is 34 euros, while the average handset list price is about 360 euros. A large majority of chosen tariffs include a handset subsidy (84%), with an average subsidy amount of 189 euros. The average commitment period is about 20.5 months, reflecting the large share of consumers choosing standard 24-month contracts. Among selected tariffs, 26% offer unlimited calls, and the average call allowance is 79 minutes. Data allowances are never offered as unlimited: they range from 0 to 10 GB, with an average of 0.87 GB. In terms of actual usage, individuals in the sample consume, on average, 84 minutes of calls and about 0.23 GB of data per month.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
Age of the subscriber (in years)	42.99	15.15	18	100
Female (0/1)	0.51	0.5	0	1
Tariff price (in euros)	34.41	20.6	4.9	169
Handset list price (in euros)	359.53	176.83	16	769.9
Tariff with handset (0/1)	0.84	0.37	0	1
Amount of handset subsidy (in euros)	188.09	123.28	0	588
Contract length (in months)	20.53	7.42	0	24
Unlimited calls (0/1)	0.26	0.44	0	1
Call allowance (in minutes)	78.98	71.22	0	360
Data allowance (in GB)	0.87	1.3	0	10
Fixed broadband (0/1)	0.15	0.36	0	1
iPhone user (0/1)	0.25	0.43	0	1
Calls (usage in minutes)	83.56	254.26	0	11691.07
Data consumption (in GB)	0.23	0.79	0	18.79
N	10,738			

Notes: The table describes the final estimation sample of 10,738 new subscribers observed between April 2011 and December 2014.

Table OA.2 shows the evolution of tariffs selected by new consumers over time. The average tariff price declined by 12% between 2011 and 2014. As a benchmark, the national-level price index for mobile tariffs declined by 38% between April 2011 and December 2014. The average handset list price declined by a similar amount, from 378 euros to 323 euros, representing a 14% decrease. The amount of subsidy granted to consumers who selected a tariff bundled with a handset decreased by almost 30%.[20]

The table also shows a sharp increase in SIM-only contract take-up. Their share increased from 3.5% of chosen tariffs in 2011 to 34% in 2014, peaking at almost 35% in 2013. The upfront price of handsets for these consumers decreased by almost 40% between 2011 and 2014, suggesting that consumers choosing SIM-only tariffs tend to select cheaper devices when they

[20]This decline in handset subsidies may seem surprising at first glance, since one might expect subsidies to increase as handsets become more sophisticated and therefore more expensive. Two opposing forces are likely at work. On the one hand, increased competitive pressure may have pushed operators to compete for premium consumers, namely consumers willing to pay for high-end tariffs bundled with high-end smartphones. This force would tend to increase handset subsidies. On the other hand, prices of tariffs bundled with handset subsidies also declined over the period. Because subsidies are computed based on tariff-price ranges, lower tariff prices mechanically reduce the subsidy available for a given handset. Results from regressions of handset subsidies (not reported in the paper) suggest that subsidies declined over the period, especially after 2013.

face the full handset cost at purchase. Over the same period, tariffs with no commitment or a shorter commitment period became increasingly popular: the share of no-commitment contracts was multiplied by 20, while the share of 12-month contracts more than doubled between 2011 and 2014. The increase in no-commitment contracts is almost entirely driven by demand for tariffs offered by the low-cost brand introduced in October 2011.[21] Table OA.2 also reports the share of observations by year. The decline in the number of observations between 2011 and 2014 reflects the operator's sampling procedure for constructing the raw dataset, rather than changes in the market environment or in subscription behavior.[22] Table OA.3 shows that observable demographics are relatively stable across cohorts, while usage and smartphone adoption increase over the sample period.

Table OA.4 reports the shares of handset brands over time. Four brands account for most selected handsets in the sample: Apple, Samsung, Nokia, and BlackBerry. Their shares are relatively stable over time, except for BlackBerry, whose share declined from 17.4% of selected handsets in 2011 to only 1.4% in 2014. The share of "Other brands" increased tenfold between 2011 and 2014. The diffusion of SIM-only tariffs appears to have enabled marginal and lesser-known brands that were previously excluded from the operator's retail channel to gain market share.

Total costs of a combination of handset and tariffs As a first step toward analyzing consumers' intertemporal choices, it is useful to describe the total costs involved, and how they differ between traditional tariffs and the newly introduced SIM-only tariffs. Figure OA.2 shows the distribution of the present value of total costs[23] of selected handset-tariff combinations over 24 months, which was the standard contract length during the observation period. Combinations involving SIM-only tariffs cost, on average, 790 euros over 24 months, with values ranging from

[21] This brand offers a small range of SIM-only contracts with online subscription and online customer service. It accounts for 98% of commitment-free subscribers in the sample.

[22] Individuals are selected among all customers of the firm based on their date of birth (day and month only). Over time, as individuals may churn, their phone numbers may be reallocated to new consumers, who then enter the sample. The high share of observations in 2012 corresponds to a period of net subscriber gains, mainly driven by the popularity of low-cost tariffs. This extraction procedure is unlikely to introduce selection bias, since the raw sample was constructed using consumer attributes that are unrelated to the variables of interest.

[23] I use an interest rate that varies with the month of subscription and is, on average, 6.03% per year.

132 euros to 2,656 euros. Combinations involving a handset subsidy are more expensive on average, with a total cost of 983 euros, and values ranging from 273 euros to 4,047 euros.

Although informative, comparing average total costs across the two types of tariffs does not allow for a precise comparison of the cost of SIM-only and traditional tariffs for similar services and the same handset. To measure the cost difference associated with choosing one option rather than the other, I match each tariff with a "twin tariff" that includes exactly the same allowances and options,[24] but differs in whether it is SIM-only or bundled with a handset subsidy. This matching procedure is successful for 364 tariffs out of 518.[25] For each consumer in the sample, I then compare the total cost of the chosen tariff with the total cost of the "twin tariff". As before, total costs are computed as the present value of payments, using an interest rate of about 6% per year. This comparison is possible for 4,680 consumers out of 10,738.

Figure OA.3 reports the resulting cost differences. It highlights that SIM-only tariffs are not always the cheapest option: negative values indicate cases in which the SIM-only alternative is more expensive than its traditional counterpart, by up to 470 euros over 24 months. Conversely, combinations involving a handset subsidy can generate an additional cost for the subscriber of up to 478 euros over 24 months. Overall, the average cost difference in this matched sample is about -75 euros, with a standard deviation of 127.8 euros, indicating that handset subsidy combinations tend to be cheaper, on average, than their SIM-only counterparts. In percentage terms, SIM-only combinations are on average 9.2% more expensive over the period.[26] Although this result may seem counterintuitive at first glance, it is consistent with the findings presented in OECD (2013).[27] Overall, the comparison illustrates that there is no contract type that is *per se* dominant: depending on the handset, the tariff, and the commitment period, either a SIM-only tariff combined with a separately purchased handset or a bundled handset-tariff contract

[24] The matched tariff also has the same commitment period: 12 or 24 months.

[25] In some cases, I cannot identify an equivalent tariff. The matching procedure also excludes SIM-only contracts with no commitment period by construction, since the operator never offers a handset subsidy when the consumer is not committed for at least 12 months.

[26] This computation is based on a reduced sample that excludes low-cost tariffs by construction. This number should therefore be interpreted with caution.

[27] The report highlights that, although tariffs bundled with handsets generally imply a higher total cost for consumers, tariffs combined with handsets may in some cases be "more economically rational than the independent acquisition of handsets." The report argues that this situation can arise in very competitive markets, and that the coexistence of SIM-only tariffs and competitively priced tariffs with handsets can expand the set of options available to consumers.

may be the cheaper option.[28]

5 Econometric model

A discrete choice framework The model developed in this paper assumes that consumers subscribe to a tariff and acquire a handset simultaneously, though not necessarily as a bundle. This assumption is most direct for consumers choosing tariffs with handset subsidies, for whom the handset is obtained at subscription, and its subsidized price is observed in the operator's catalog. It is a stronger assumption for SIM-only consumers, for whom I observe the handset used at subscription but not the exact purchase date or transaction price. I therefore exclude SIM-only consumers using handsets that were no longer available on the market at the time of subscription.[29]

The upfront payment at subscription is defined as the price paid for the handset. It equals the handset list price if the selected tariff is SIM-only, and the subsidized handset price (i.e., the list price minus the subsidy) if the selected tariff is a tariff bundled with a handset. The recurring charge is the monthly tariff price, which is paid until the end of the contract. Over the life of the contract, the sum of these monthly charges represents what I refer to in this paper as *future costs*.

Discrete choice models are commonly used to analyze demand for telecommunications products. These models describe situations in which an agent, such as a consumer or a firm, chooses among a set of available options, either once or repeatedly over time. In this framework, each

[28] However, this comparison should be interpreted narrowly. It compares matched tariff-handset combinations while holding allowances and commitment length fixed; it does not establish whether consumers would have selected larger allowances, more expensive handsets, or longer commitments absent handset subsidies. Such concerns about overpayment are related to the evidence in Genakos et al. (2023), who show that mobile consumers may remain on more expensive plans despite being informed about potential savings. Assessing whether consumers would choose different allowances, handsets, or contract forms under full attention is an interesting policy question, but it is outside the scope of the present paper.

[29] In the data, I observe the handset used at subscription through its International Mobile Equipment Identity (IMEI), which is registered in the operator's information system. I do not know when the handset was purchased, nor the price the consumer paid. For consumers who subscribed to a tariff with a handset subsidy, representing 84% of observations in the sample, both timing and price are observed correctly by construction: the handset is obtained at subscription at a price that depends on the chosen tariff and is advertised in the operator's catalog. For SIM-only consumers, I cannot verify that the handset was purchased at the time of subscription. I therefore drop SIM-only consumers who use handsets that were no longer available on the market and could not have been purchased new at the time of subscription.

individual chooses the alternative that maximizes utility, where utility depends on product attributes, individual characteristics, and the weights assigned to different components and attributes. Since the dataset contains alternative-specific variables, I estimate a conditional logit model.

The first step is to define an exhaustive and mutually exclusive choice set. Consumers are assumed to choose a handset-tariff combination from all available combinations in the month of subscription. Each alternative is constructed by combining one tariff from the list of available tariffs with one handset from the list of available handsets in that month.[30] Constructing an exhaustive choice set would be computationally impractical: each individual choice set would contain about 70,000 alternatives, implying a final dataset of more than 752 million observations. I therefore sample a fixed number of tariffs and handsets to construct individual choice sets.[31] This is a standard approach in the discrete choice literature (see, e.g., Train et al., 1987).

Since April 2011, most available tariffs have been offered in several "versions", differing in contract length and whether they include a handset subsidy. Prices vary across these versions. The version associated with the lowest recurring charge is typically the one without a handset subsidy. These SIM-only versions are offered either without commitment or with a 12-month commitment period, the latter usually being about 5-10 euros cheaper per month than the no-commitment version. Tariffs with handset subsidies are associated with 12 or 24-month commitment periods, with 24-month contracts usually involving lower monthly prices.

In the choice set, in addition to the selected tariff, I include 10 randomly selected tariffs. Each tariff appears in all its available versions, depending on whether it includes a handset subsidy, is SIM-only, and comes with or without commitment. As a result, the number of unique tariff versions in the choice set varies between 11 and 54. These tariffs are then combined with the selected handset and 10 randomly sampled handsets. Handsets not listed in the operator's catalog are available only with SIM-only tariffs. Each individual choice set therefore contains

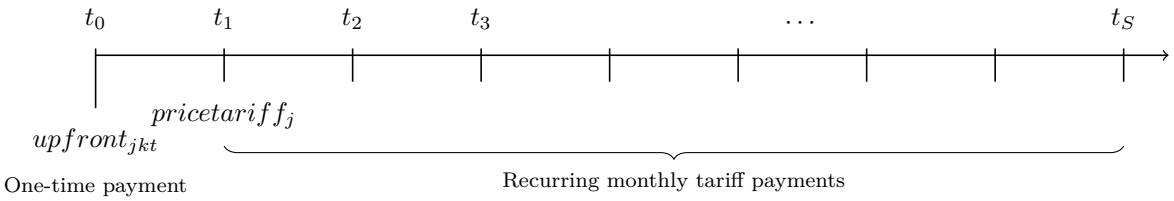
[30] Most of these handsets are listed in the operator's catalog, in which case I use the list price from this catalog. In practice, consumers may purchase handsets from other retailers, but I assume that their prices equal the operator's list prices. For handsets not included in the operator's catalog, I use the official release price in the national market or prices from IDC.

[31] Section 8.2 reports robustness checks using larger sampled choice sets and alternative sampling procedures, and shows that the estimated coefficients of interest are stable.

between 209 and 550 alternatives.[32] This variation reflects differences in the number of versions available for each tariff.

An intertemporal decision Consider a consumer i who selects tariff j and handset k at month t. This decision affects her intertemporal budget constraint in two ways. First, she pays an upfront cost, $upfront_{jkt}$, at t_0, the time of subscription. Second, she pays a recurring charge, $pricetariff_j$, from t_1 to t_S, over the life of the contract, denoted by S. Figure 2 illustrates this intertemporal decision.

Figure 2: Timing of upfront and recurring payments



The upfront handset cost, $upfront_{jkt}$, equals the handset list price if a SIM-only tariff is chosen, and the list price net of the operator's subsidy if a traditional tariff is chosen. It therefore varies across tariffs j, handsets k, and time t. The recurring charge, $pricetariff_j$, varies only across tariffs j. The future costs considered by consumers are computed as the present value of future recurring charges.[33] To compute this present value, I follow the approach in Grigolon et al. (2018).

$$PT_{jt} = \frac{pricetariff_j}{(1+r_t)^1} + \frac{pricetariff_j}{(1+r_t)^2} + ... + \frac{pricetariff_j}{(1+r_t)^{S_j}} = \frac{1}{r_t}[1-(1+r_t)^{-S_j}]pricetariff_j$$

where PT_{jt} denotes the present value of future costs for a tariff j selected at time t, $pricetariff_j$ denotes the price of the tariff j, S_j is the time horizon of the choice which varies over tariffs j, and r_t which denotes the market interest rate at the time of decision t. Therefore,

[32] All combinations of tariffs and handsets in the choice set are theoretically possible: the operator's catalog defines a subsidy level for each handset by ranges of tariff prices.

[33] I assume here that the consumer's monthly bill is equal to the tariff list price. I discuss the rationale for this assumption and its implications in the subsection "Measurement of recurring charges" later in this section.

PT_{jt} varies across tariffs j as their monthly charge and contract length vary (impacting S), and over time t as the interest rate r also varies.

For r_t, I use the average consumption-credit rate granted by national banks, which ranges from 5% to 6.15% per year over the period.[34] This value is very close to the assumptions made by Allcott and Wozny (2014) and Grigolon et al. (2018), who both use $r = 6\%$ to compute the present value of future payoffs in the automobile market.[35] I convert the annual rate into a monthly rate because the time periods considered in the model are months. Section 8.2 discusses robustness checks in which I re-estimate the model using alternative interest rate assumptions. These include both lower and higher rates, based on short-term deposit rates and revolving consumer credit rates, ranging from 1% to 15.2% depending on the scenario and month.

For S_j, which represents the time horizon consumers consider when trading off present and future costs, I use the commitment period associated with the tariff when the contract includes one. When the contract is not associated with a commitment period, as is the case for many SIM-only tariffs, I set S_j equal to 19 months, which corresponds to the average time a non-committed consumer keeps her tariff in the data.[36] The horizon S_j should be interpreted as the payment horizon used to capitalize future recurring charges at the time of subscription, not as an assumption that utility from the tariff ends after the contractual period. Because this assumption is important, Section 8.2 re-estimates the model under alternative common horizons of 12, 24, and 32 months and discusses how the estimates of interest change.

[34] This information is publicly available on the website of the country's central bank.

[35] Allcott and Wozny (2014) and Grigolon et al. (2018) use $r = 6\%$ as the market interest rate when computing the valuation of future payoffs in the automobile market. They rely on a weighted average of discount rates for financed and cash payments. In the data used by Allcott and Wozny (2014), 37% of vehicles are financed at an average real interest rate of 6.9%, while 63% are purchased in cash. For cash purchases, the opportunity cost of funds is assumed to be equal to S&P 500 returns, which were 5.8% at the time of the study. The resulting weighted average is 6.2%, which they approximate by 6%.

[36] The existing literature often sets the time horizon equal to the expected or average lifetime of the good. In the case of heating or cooling systems, or cars, goods can typically be resold at any time, and no contractual relationship binds the consumer to the retailer after purchase. The setting studied here is different because consumers are often tied to the operator by a commitment period and may face a potentially high termination fee if they switch before the end of the contract. If one wanted to use a horizon closer to those used in previous papers, the handset replacement cycle would be a natural proxy. In this case, S would be close to 32 months, which is the handset replacement cycle in this country as estimated by Recon Analytics in 2012 (See the source cited earlier). I consider this value for S in an alternative specification presented in Section 8.2.

Utility function I use a standard linear utility specification for individuals $i = 1, \ldots, N$, tariffs $j = 1, \ldots, J$, and handsets $k = 1, \ldots, K$. Utility depends on tariff and handset characteristics, as well as on observed and unobserved individual characteristics. The indirect utility of individual i from choosing tariff j and handset k at time t is given by:

$$U_{ijkt} = x'_{jk}\beta - \alpha_{it}(upfront_{jkt} + \gamma_{it}PT_{jt}) + \xi_j + \xi_k + \varepsilon_{ijkt} \tag{1}$$

where x'_{jk} is a vector of tariff and handset characteristics. It includes categorical variables for data allowances (500 MB, 1 GB, 2 GB, 4 GB, or 10 GB); a dummy for unlimited calls; call allowance measured in minutes for tariffs that do not include unlimited calls; a dummy for the fixed-broadband option; and a categorical variable for tariff type, which combines the handset-subsidy option and the commitment period. The vector also includes dummies for the main handset brands in the sample; a dummy for smartphone; handset-model age, measured in months; handset height, width, and thickness, measured in millimeters; camera quality, measured in megapixels; battery life, measured in hours; and a dummy for 4G handsets when the tariff is compatible with 4G services. The variable $upfront_{jkt}$ denotes the upfront handset cost, and PT_{jt} denotes the present value of future costs. I interact these two variables of interest with quarters of subscription, age groups, and gender. The terms ξ_j and ξ_k capture unobserved tariff and handset characteristics, respectively.[37] The term ε_{ijkt} is the idiosyncratic error term.

The vector of coefficients β captures the average valuation of handset and tariff characteristics. The coefficient α_{it} denotes the marginal utility of income for individual i making a decision at time t.[38] The key parameter of interest is γ_{it}. Following the valuation-weight interpretation in Allcott and Wozny (2014) and Grigolon et al. (2018), I interpret it as an *attention weight* on future recurring tariff payments. In the model, γ varies by quarter of subscription and across individuals. To obtain γ_{it}, I can estimate the following equation:

$$U_{ijkt} = x'_{jkt}\beta - \alpha_{1it}(upfront_{jkt}) + \alpha_{2it}(PT_{jt}) + \xi_j + \xi_k + \varepsilon_{ijkt} \tag{2}$$

[37] They are obtained from first stage regressions that I describe later in this section.

[38] In the main specification, α_{it} does not vary at the individual level in the strict sense; instead, it varies by age group, gender, and time.

where α_{1it} denotes the price coefficient for the upfront cost and α_{2it} is the price coefficient for the present value of future costs. Then, I can retrieve γ_{it} based on the equivalence of Equation (1) and Equation (2).

$$\alpha_{it} = \alpha_{1it} = \frac{\alpha_{2it}}{\gamma_{it}} \rightarrow \gamma_{it} = \frac{\alpha_{2it}}{\alpha_{1it}} \tag{3}$$

Interpretation of γ The attention weight γ determines how the present value of future recurring payments is weighted relative to the upfront handset cost. If $\gamma_{it} = 0$, future recurring charges do not enter the subscription decision. If $\gamma_{it} = 1$, consumers weigh the present discounted value of future charges one-for-one with the upfront payment. If $\gamma_{it} > 1$, future charges receive more than full weight in the decision. γ_{it} should not be interpreted as a structural preference parameter. Rather, it captures how much attention consumers appear to pay to future recurring payments when choosing a handset-tariff combination, conditional on the assumed payment horizon and market interest rate. Figure A.4 illustrates how the interpretation of γ depends on the two parameters used to compute the present value of future recurring payments: the market interest rate r and the payment horizon S.[39]

This interpretation is also important for understanding time variation in γ. A change in γ does not imply that consumers' intertemporal preferences changed over the sample period. Rather, it indicates that the relative weight placed on future monthly payments in observed choices changed. The market events studied in this paper provide a natural mechanism for such a change in attention. The introduction of SIM-only tariffs separated the handset purchase from the service contract, making monthly recurring prices easier to compare across offers. At the same time, the new entrant engaged in communication around the cost of traditional handset subsidies. Public statements explicitly emphasized that subsidized handsets could hide high total costs over the life of the contract. These events increased the salience of recurring charges and of the total cost of ownership, an interpretation consistent with the Google Trends evidence

[39]The figure on the left shows that rationalizing values of γ close to the main estimate under full attention would require implausibly high annual interest rates, far above those used in the baseline and robustness specifications. The figure on the right shows that the value of γ required for full attention is more sensitive to the assumed payment horizon. This motivates the robustness checks in Section 8.2, where I consider alternative values of S.

presented in Figure A.3, which shows increased search activity around tariff prices, SIM-only offers, and handset subsidies during this period. I therefore allow γ to vary over time because the information environment, price framing, and "returns to paying attention" changed over time. I also allow γ to vary across observed consumer characteristics, such as age and gender, to capture heterogeneity across groups. I do not interpret these differences as evidence of different structural estimates of time preferences.

Price endogeneity and unobserved product attributes Prices may be correlated with unobserved handset and tariff quality: the upfront handset cost may be correlated with unobserved handset attributes, while the present value of future recurring payments is based on tariff prices that may be correlated with unobserved tariff characteristics. If products with higher unobserved quality are also priced more expensively, standard estimation methods that assume independence between prices and the utility error may yield price coefficients biased toward zero. I address this issue in the baseline specification using the control function approach suggested in Petrin and Train (2010). The logic of this approach is to use an auxiliary equation, here the pricing equation, to recover information about the component of prices that is correlated with unobserved demand factors. This recovered component is then included directly in the demand equation.

The procedure is in two steps. First, I estimate reduced-form pricing equations for handsets and tariffs. These equations relate prices to observed product characteristics and to *cost shifters*. The latter enter the first stage price equations but are excluded from the utility function. Second, I include the estimated residuals from these pricing equations in the utility specification. As in Petrin and Train (2010), these residuals proxy for the part of prices that is correlated with unobserved utility. Conditional on the control function, the remaining variation in prices is assumed to be independent of the unobserved utility component.

For handsets, the excluded variables are constructed from variation in component-cost trends. Handset prices depend on technological components such as the screen, camera, battery, chipset, and LTE compatibility. The costs of supplying these components change rapidly over time and not necessarily at the same pace across characteristics. For example, the cost of providing a given

camera quality or screen size may decline as the technology matures, while newer features such as LTE compatibility may initially remain costly. I therefore interact several observed handset characteristics with a time trend in the handset price first stage regression. The identifying assumption is not that consumers do not value these characteristics. On the contrary, handset characteristics such as camera quality, dimensions, battery life, smartphone dummy, and brand are directly controlled for in the utility specification. The exclusion restriction is instead that, conditional on these observed characteristics and time effects, changes over time in the cost of supplying a given characteristic affect handset prices but do not directly shift consumers' utility. Consumers may value a larger screen or a better camera, but they are unlikely to observe or value separately the component-level cost decline associated with producing that feature. These interactions, therefore, provide supply-side variation in handset list prices.

For tariffs, I use variation in mobile termination rates as the preferred excluded cost shifter. Mobile termination rates (hereafter, MTRs) are wholesale charges paid by one mobile operator to another when a subscriber places a call to a customer on a different network. They affect the marginal cost of providing voice services, especially for tariffs with large call allowances or unlimited calls. I focus on call termination rates rather than SMS termination rates because SMS are unlimited in the tariffs considered here, making SMS termination costs less useful for generating differential cost variation across plans.[40] Call MTRs, measured in euro cents per minute, naturally interact with the amount of voice service included in the tariff. The identifying assumption is that changes in regulated MTRs shift the cost of supplying voice-intensive tariffs but do not directly affect consumers' utility, once the demand specification controls for call allowances. Indeed, a reduction in the wholesale cost of terminating calls makes generous voice tariffs (e.g., unlimited calls) cheaper to supply, independently of consumers' valuation of the corresponding voice allowance. I therefore interact the call MTR with call-allowance categories and the unlimited-calls indicator in the tariff-price first stage regression. I also report specifications that use the number of active 4G antennas as an alternative source of supply-side cost variation for tariffs. The motivation is that network deployment affects the

[40] Over the focal period, mobile termination rates decreased by discrete steps. For MNO 1, the termination rate fell from 3 cents per minute at the beginning of the sample to 2 cents in mid-2011, 1.5 cents in early 2012, 1 cent in mid-2012, and 0.8 cents from early 2013 onward.

cost of providing data-intensive mobile services. I therefore include interactions between data allowance, 4G compatibility, and the number of active 4G antennas. These antenna-based cost shifters are reported for transparency, but I do not use them in the preferred control-function specification.[41]

Although the control-function approach provides a reasonable correction for price endogeneity, its identifying assumptions cannot be tested directly. The first and second stage results are nevertheless consistent with the intended interpretation of the control functions. In the first stage regressions, the excluded cost shifters have explanatory power for handset and tariff prices.[42] In the demand estimation, the residuals from the handset-price and tariff-price regressions enter positively and significantly. This is consistent with the interpretation in Petrin and Train (2010): a positive pricing residual indicates that a product's price is higher than predicted by observed characteristics and cost shifters, and a positive coefficient on this residual suggests that it captures unobserved product attributes valued by consumers. I nevertheless complement the baseline specification with an alternative fixed-effects approach in Section 8.2. Following Berry et al. (2004) and Goolsbee and Petrin (2004), I estimate specifications with a large number of tariff and handset fixed effects.[43] This specification provides a complementary way to capture persistent unobserved product quality and reduces reliance on the excluded cost shifters.

Measurement of recurring charges The baseline specification uses the tariff list price as the monthly recurring charge. Actual bills may differ from this amount because of overages caused by roaming, as well as calls or data use outside the allowance. This implies that PT_{jt} may understate expected future payments. If such bias is present, its direction depends on how omitted overage charges vary across tariffs. Roaming charges, for example, are typically not tied to the selected plan and are priced uniformly across tariffs. As additive charges that are common across alternatives for a given consumer, they do not affect utility differences across

[41] The interactions with the number of antennas are not statistically significant in the first stage regression, suggesting that this instrument has limited explanatory power.

[42] These results are presented in Tables OA.5 and OA.6.

[43] Since many products are rarely selected, I include fixed effects for the most frequently selected tariffs and handsets rather than for every product in the catalog.

tariff choices. By contrast, overages for calls or data are more likely to be related to the level of allowances. If overages are higher for cheaper or less generous tariffs, they are negatively correlated with the tariff list price. In that case, using the list price alone tends to attenuate the coefficient on future costs toward zero. Since both α_{1it} and α_{2it} are negative, this would lower the estimated value of $\gamma_{it} = \alpha_{2it}/\alpha_{1it}$, and possibly lead to an understatement of consumers' attention weights.

However, several features of the focal setting suggest that this concern is limited. First, charges unrelated to the selected tariff, such as roaming charges in destinations not covered by any plan, can be viewed as additive charges common across all alternatives for a given consumer. As mentioned above, such charges do not affect utility differences across alternatives and therefore should not affect the estimated price coefficients.[44] Second, the subscription decision depends on the expected bill *at the time of choice*, not on the bill realized ex post. Consumers are likely to consider and compare predictable monthly charges across plans, but may be less likely to fully internalize future overage charges arising from temporary usage shocks or travel, since these depend on circumstances that are uncertain at the time of choice. Third, observed usage in the sample, together with consumer-survey evidence from Ofcom (2012) suggests that large systematic overages are unlikely for the average consumer, although bill shocks may occur and can be substantial when they do. I discuss this issue in more detail in Section OA.3.

Choice probabilities and estimation I estimate the model using the standard discrete choice framework described in Train (2009). Each individual is assumed to choose the alternative that maximizes utility among the alternatives in her choice set. Utility is decomposed into an observable component and an idiosyncratic error term.

Individual i chooses the combination of tariff j and handset k at time t if this alternative yields the highest utility among all available alternatives in her choice set. Let V_{ijkt} denote the component of utility observed by the researcher.

[44] Indeed, only differences in utility across alternatives matter for the choice probability. This is a standard implication of the logit model: choice probabilities are invariant to adding the same constant to the utility of all alternatives in a choice set; see, for example, Train (2009).

$$U_{ijkt} = V_{ijkt} + \epsilon_{ijkt} \tag{4}$$

I assume that the idiosyncratic error term follows a Type I extreme value distribution. Under this assumption, the probability that individual i chooses a given handset-tariff combination is determined by the utility of that alternative relative to the utilities of all other alternatives in her choice set.

The dataset contains both individual characteristics and alternative-specific characteristics, such as tariff prices, handset prices, and handset and tariff attributes. The main model includes both alternative-specific regressors and interactions between case-specific variables (such as age group and subscription quarter) and alternative-specific variables. I estimate a conditional logit model by maximum likelihood, grouping observations at the consumer-choice level, using the `clogit` command in Stata.

Because alternatives are defined as handset-tariff combinations, the same handset can appear in several alternatives with different tariffs, and the same tariff can appear in several alternatives with different handsets. The baseline conditional logit model treats these combinations as distinct alternatives and imposes the standard proportional-substitution pattern across them. This assumption may be restrictive if alternatives sharing the same handset or the same tariff also share unobserved utility components. Several features of the empirical approach mitigate this concern. First, the data include detailed characteristics of both tariffs and handsets, including tariff type, commitment length, handset-subsidy dummy, call and data allowances, handset brand, and key technical characteristics. These variables capture many of the observed dimensions along which alternatives sharing a handset or tariff are similar. Second, I conduct robustness checks using two alternative specifications. The product fixed-effects specifications absorb persistent unobserved quality for the most frequently selected tariffs and handsets. The mixed logit specification allows for random coefficients on the two price components entering utility and therefore relaxes the proportional-substitution restriction along the dimensions central to the paper: the trade-off between the upfront handset cost and future recurring tariff payments. Both exercises support the qualitative robustness of the main result, namely the in-

crease in the attention weight over time.[45] Because the counterfactual simulations are based on the conditional logit specification, they inherit its substitution structure. I therefore discuss this limitation explicitly in Section 7 and interpret the resulting welfare magnitudes with caution.

Consumer surplus In the counterfactual simulations, I compute changes in surplus using the standard log-sum approach for discrete choice models, following Train (2009). For each consumer and each scenario, I calculate the inclusive value of the available handset-tariff alternatives using the deterministic component of utility. The change in surplus between two scenarios is then obtained as the difference between the corresponding inclusive values, scaled by the individual-specific marginal utility of income, using the coefficient on the upfront payment to convert utility units into euros. Since the absolute level of utility is not identified, the unknown additive constant cancels out when comparing scenarios. I therefore interpret only changes in surplus, computed at the individual level and then averaged across consumers.

Because γ is interpreted as a revealed-choice attention weight rather than as a structural preference parameter, these changes should be understood as changes in decision-weighted surplus under a given utility specification. In the counterfactual analysis, surplus changes under the estimated attention weights are compared to the baseline computed under the same estimated attention weights. When I impose the full-attention benchmark, $\gamma = 1$, surplus changes are instead computed relative to the corresponding full-attention baseline. The surplus levels and surplus changes obtained under the estimated γ and full-attention utility specifications should therefore not be compared directly, because the underlying utility function differs. I return to this point when presenting the counterfactual results in Section 7.

6 Estimation results

Main demand estimates Table A.1 shows results from the main models. Model I presents the estimates from a model that includes no interactions and no residuals from the first stage

[45] The product fixed-effects results are presented in Tables OA.15 and OA.16, and in Figure OA.14. They show that, although the level of the price coefficients changes to some extent, as expected when fixed effects absorb persistent unobserved product quality, the increase in the attention weight over time remains. The main mixed logit results are presented in Table OA.17.

regressions. Model II includes the residuals from tariff price and handset price regressions.[46] Model III includes interactions between time and both price components: the upfront handset cost and the present value of future recurring costs. Model IV includes interactions between prices and time, as well as interactions between prices and consumer characteristics, namely age groups and gender. I discuss the estimates from Model IV, which is the most complete and preferred specification. The estimated coefficients are highly significant, have the expected signs, and are plausible in magnitude. In particular, I obtain negative coefficients for the upfront cost ($\alpha_1 = -0.009$) and for the present value of future costs ($\alpha_2 = -0.003$). The magnitude of the upfront-cost coefficient is comparable to estimates from the smartphone-demand literature. For example, Fan and Yang (2020) estimate a random-coefficients demand model for the U.S. smartphone market and obtain a coefficient of -0.007 on the subsidized retail price of smartphones.[47]

Data allowances are positively valued, with coefficients ranging from 1.14 for 500 MB to 3.05 for 10 GB. Tariffs are offered with either unlimited calls or limited call allowances ranging from 30 to 600 minutes. The unlimited-calls option is highly valued relative to the base category, and each additional minute of call allowance is also positively valued. The fixed-broadband option, which provides home access to fixed internet and telephony, is also highly valued.

Regarding tariff type, defined by the handset subsidy option and contract length, the base category is the most common: a 24-month contract with a handset subsidy. The coefficients associated with other tariff types are negative and significant, suggesting that consumers value the possibility of bundling their mobile tariff and handset within a long-term contract, after controlling for the components captured by the price coefficients.

Handset-brand dummies capture consumers' valuation of the main brands relative to marginal brands, which form the base category. Apple and BlackBerry products are particularly highly valued. The smartphone dummy is also positive and significant. The coefficient on handset age,

[46] Estimates from the first stage regressions are shown in Tables OA.5 and OA.6 in the Online Appendix.

[47] This comparison should be interpreted cautiously because the markets and choice environments differ. Nevertheless, it suggests that the estimated sensitivity to the upfront handset price is of a plausible order of magnitude. A similarly direct benchmark is harder to provide for the coefficient on the present value of future recurring charges, since most related studies estimate demand responses to monthly plan prices or usage prices rather than to the present value of future recurring payments in a joint handset-tariff choice model.

measured by the number of months since the model was released, is negative, indicating that consumers prefer more recent models. The positive coefficient on handset height is consistent with a preference for larger screens. The positive coefficient on thickness should be interpreted with caution: it does not imply that consumers prefer thicker handsets. Instead, thickness may proxy for remaining handset attributes or design features that are not fully captured by the observed characteristics. Camera quality, measured in megapixels, and battery life, measured in stand-by time, are both valued positively. Finally, alternatives combining an LTE-compatible handset with a 4G-compatible tariff have a positive and significant effect on utility, consistent with consumers valuing access to this recent technological improvement.

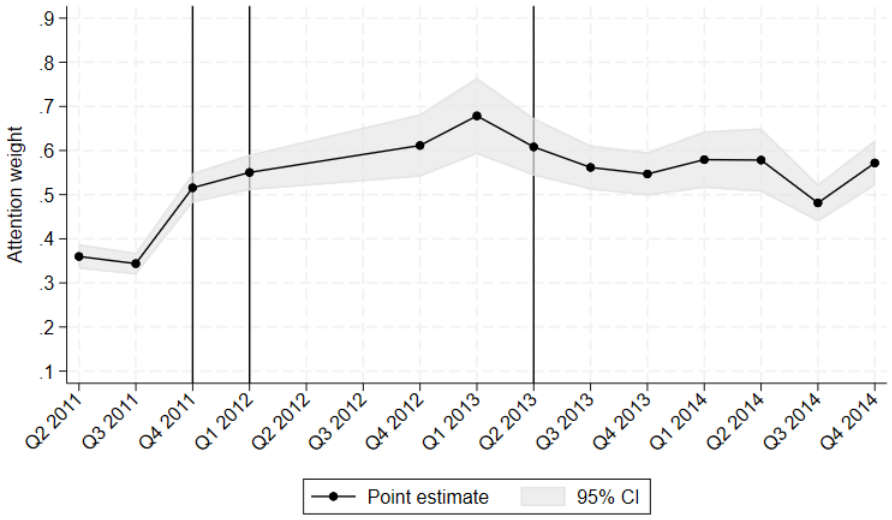
To account for the potential endogeneity of tariff and handset prices, I use the control-function approach described in Section 5. The residuals from the first stage price regressions enter the demand equation positively and significantly, with coefficients of 0.006 for handsets and 0.006 for tariffs.[48] This is consistent with Petrin and Train (2010): positive pricing residuals capture unobserved product attributes valued by consumers. As shown by the comparison between Models I and II, including the control-function residuals increases the upfront-price coefficient in absolute value. This indicates that, without correcting for price endogeneity, the upfront-price coefficient is biased toward zero.

Interaction with time, age, and gender Figure A.5 reports the estimated coefficients on interactions between prices, subscription quarter, and consumer characteristics. The estimates point to a clear pattern: both price coefficients α_1 and α_2 vary systematically with age and gender, whereas variation over time is observed primarily for the coefficient on the present value of future costs.[49] I interpret this asymmetry in light of the market changes described in Section 3: the diffusion of SIM-only tariffs, together with the public attention surrounding handset

[48] Tables OA.5 and OA.6 report the first stage regressions. The excluded variables are statistically significant and have explanatory power for handset and tariff prices, supporting their relevance as cost shifters.

[49] For α_1, the coefficient on the upfront handset cost, most quarter interactions are not statistically significant, suggesting little time heterogeneity. Socio-demographic interactions are significant: younger consumers are less sensitive to the upfront cost than consumers aged 45-54, while older and female consumers are more sensitive. For α_2, the coefficient on the present value of future recurring costs, most quarter interactions are statistically significant, indicating that sensitivity to future payments changed over time. The estimates also show similar heterogeneity across consumer groups, with lower sensitivity among younger consumers and higher sensitivity among female consumers.

Figure 3: Attention weight γ over time



Notes: The figure reports the evolution of γ based on the preferred conditional logit specification, Model IV in Table A.1. Quarters Q2 and Q3 2012 are omitted because they contain too few observations to yield reliable estimates. The vertical lines mark the main market events used to interpret changes in attention: the introduction of SIM-only tariffs, the entry of the new MNO, and the commercial launch of 4G services.

subsidies and total contract costs, plausibly affected how salient future recurring payments were to consumers, rather than generating a general change in sensitivity to all price components of the choice. The distributions of α_{1it} and α_{2it} are obtained by combining the main price coefficients with the corresponding time, age-group, and gender interactions. They are reported in Figure A.6.

Attention weight Based on the price coefficients, I compute the attention weight γ as the ratio of the coefficient on the present value of future recurring costs (α_2) to the coefficient on the upfront handset cost (α_1).

Figure 3 presents the main result of the paper: the evolution of the attention weight γ over time.[50] At the beginning of the sample period, the attention weight is stable at around 0.35, indicating substantial undervaluation of future recurring payments. It then increases sharply to

[50]Results for the second and third quarters of 2012 are omitted because the number of observations in these quarters is too small to obtain reliable estimates. The corresponding interaction terms have large standard errors, without affecting the overall estimation results.

0.52 in the last quarter of 2011, coinciding with the introduction of low-cost SIM-only tariffs. The attention weight continues to rise afterward, reaching 0.68 in the first quarter of 2013. This suggests that consumers are still underweighting future costs, but much less so than at the beginning of the period. After the launch of 4G services by the operator, γ declines moderately, from 0.68 to 0.60, and then stabilizes around 0.55.

These values can be compared with estimated attention weights in other markets. Allcott and Wozny (2014) estimate an average attention weight of 0.76 for car buyers in the United States, while Grigolon et al. (2018) estimate an average of 0.91 for car buyers in Europe. The estimates, therefore, suggest that consumers choosing a handset and mobile service underweight future costs more strongly than consumers choosing cars, implying a higher degree of myopia in this setting.

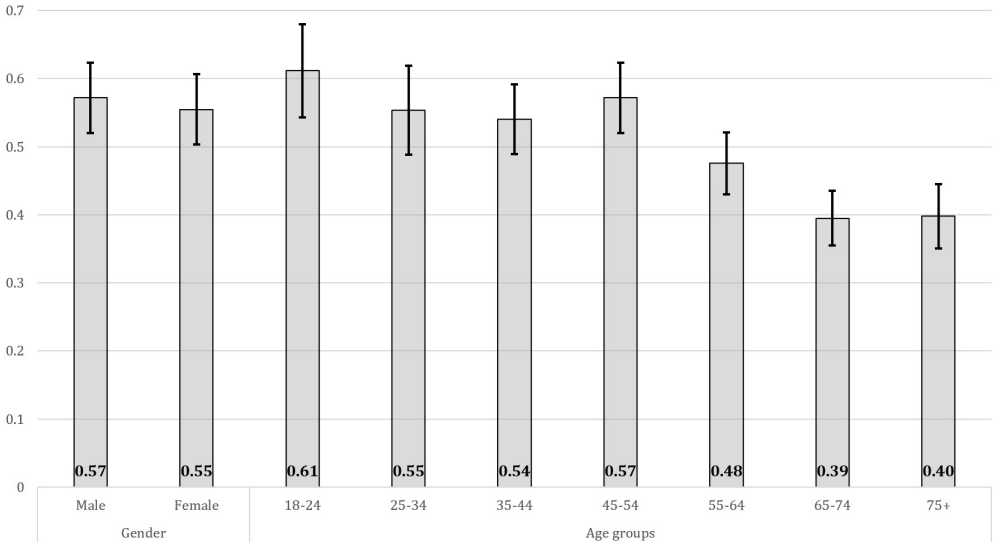
A natural interpretation issue is whether this increase partly reflects the growing share of consumers choosing SIM-only tariffs in the sample, which could mechanically raise the average value of γ. I return to this issue in more detail in Section 8.2, where I re-estimate the model on restricted samples of consumers choosing committed contracts and consumers choosing traditional tariffs with handset subsidies. The increase in γ remains substantial in both samples, suggesting that the evolution of the attention weight is not driven mechanically by changes in the composition of subscribers.

Figure 4 shows how γ varies by age group and gender, holding the subscription quarter fixed at Q4 2014. The attention weight is slightly higher for male than for female subscribers, but the difference is not statistically significant. By age, γ is relatively similar across consumers aged 18 to 54, while it tends to decline for consumers aged 55 and above.[51]

Figure 5 reports the resulting distribution of γ_{it} for the full sample, after computing an individual-specific attention weight based on the time, age, and gender interactions. The average value is 0.44, with values ranging from 0.24 to 1.08 and a standard deviation of 0.11.

[51] These differences should be interpreted as heterogeneity in the relative attention paid to future tariff payments, not as direct evidence of heterogeneous time preferences.

Figure 4: Heterogeneity of attention weight γ across consumers, based on observable characteristics

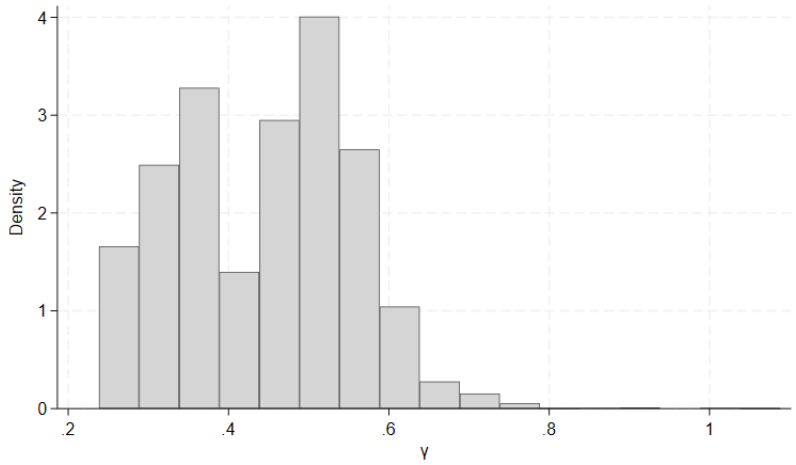


Notes: The figure reports the estimated attention weight γ by gender and age groups, holding the subscription quarter fixed at Q4 2014. These results are based on the estimates from Model IV presented in Table A.1. Vertical bars report 95% confidence intervals.

Interpretation of the main results As noted above, the evolution of γ over time is consistent with a change in the attention consumers paid to future recurring charges. The timing of the increase coincides with two closely related market events: the launch of low-cost SIM-only tariffs by incumbent operators and the entry of a new mobile network operator. These events not only expanded the choice set or reduced prices; they also changed the way handset-service contracts were framed by operators. By separating the handset purchase from the mobile-service subscription, SIM-only tariffs made monthly fees easier to compare across offers and made the implicit trade-off between upfront handset payments and future recurring charges more transparent.

The entrant's marketing strategy likely reinforced this mechanism. By exclusively offering SIM-only contracts, the entrant positioned its plans as an alternative to traditional subsidized-handset bundles and explicitly highlighted the total cost of ownership associated with those bundles. As discussed in Section 5, this positioning, along with surrounding media coverage, likely increased the salience of recurring charges and handset subsidy costs. The Google Trends evidence presented and discussed above in Figure A.3 is consistent with this interpretation:

Figure 5: Attention weight (γ) for the full sample



Notes: The figure reports the distribution of the individual-specific attention weight γ for the 10,738 consumers in the estimation sample. Values are computed from the preferred specification, Model IV in Table A.1, using the estimated interactions with subscription quarter, age group, and gender. Values below one indicate that future recurring payments receive less weight than the upfront handset payment in observed choices.

search activity for terms related to tariff prices, SIM-only offers, and handset subsidies rose over the same period. While this evidence is descriptive and measured at the national level, it suggests that these market events coincided with greater public attention on these focal dimensions. Disentangling the separate effects of these events is difficult because the launch of low-cost SIM-only offers and the entry of the new operator were intrinsically connected, as discussed in Section 3. I therefore interpret the evolution of γ as evidence of a broader change in the market environment, rather than as the causal effect of a single event.

The events studied in this paper can be interpreted through the lens of Gabaix and Laibson (2006). In their model, firms may shroud costly add-ons when some consumers are myopic, while a competing firm may attract consumers by making the shrouded attribute more salient, thereby "debiasing" them. Such debiasing need not induce all newly informed consumers to switch. Once the hidden cost becomes salient, some consumers may switch to the firm that "unshrouds" the attribute, whereas others may remain with incumbent firms but make choices in a more transparent environment. In my setting, the entrant and the diffusion of SIM-only tariffs made the implicit cost of handset subsidies more visible. Some consumers may have

responded by switching to the entrant, while others remained with incumbent operators but faced a choice environment in which handset subsidies and recurring charges were more salient. The increase in γ among subscribers to the focal operator is consistent with this type of partial "debiasing" mechanism.

The decline in γ around the commercial launch of 4G services is also consistent with the view that changes in the market environment affect how consumers weigh upfront and future recurring costs. 4G adoption required consumers to consider newer, often more expensive LTE-compatible handsets, which operators frequently promoted through offers with low upfront prices. Such offers may have shifted attention back toward the immediate handset payment and away from future recurring charges.

Before turning to the counterfactual analysis, I consider one alternative interpretation. The evolution of γ could partly reflect liquidity constraints rather than changes in attention: some consumers may choose contracts with low upfront handset prices because they cannot afford a higher upfront payment, rather than because they underweight future recurring payments. I cannot rule out this mechanism for some individuals. However, it is unlikely to explain the overall pattern since observable socio-demographic characteristics remain stable across cohorts, as shown in Table OA.3. I therefore interpret the evolution of γ primarily as a change in attention to future recurring payments, while acknowledging that liquidity constraints may also shape some consumers' choices.

7 Counterfactual simulations

Counterfactual design The estimates from the discrete choice model can be used to simulate how consumers' choices and the corresponding changes in surplus would differ across alternative market environments. I use these simulations to assess the relative importance of two changes documented above: the decline in the average tariff price and the introduction of SIM-only tariffs.

The baseline environment corresponds to the observed situation, in which consumers face the observed choice sets, observed handset prices, and observed tariff prices. I first construct a

counterfactual environment without the post-October-2011 decline in tariff prices.[52] To do so, I estimate a hedonic tariff-price regression using only the pre-shock period, i.e., Q2-Q3 2011. The regression explains monthly tariff list prices using observed tariff characteristics, including call allowance, data allowance, contract length, a handset-subsidy dummy, fixed-broadband options, and other tariff attributes. I then use the estimated coefficients to predict counterfactual prices for tariffs available after October 2011, based on the pre-shock relationship between characteristics and prices. Table OA.7 reports the hedonic price regression used for this exercise, and Figure OA.5 shows the corresponding predicted prices.

I then construct a counterfactual environment without SIM-only tariffs. Operationally, I assign SIM-only alternatives an arbitrarily high price, here 10,000 euros, so that their predicted choice probability becomes effectively zero. This is equivalent to withdrawing SIM-only alternatives from the choice set. Consumers are then reallocated across the remaining handset-tariff combinations offered by the focal operator, according to the estimated choice probabilities. This simulation captures the value of access to SIM-only tariffs within the focal operator's product portfolio, holding fixed the set of consumers observed in the data.

I combine these two simulations into three market counterfactual scenarios. In Scenario 1, SIM-only tariffs remain available, but tariff prices are replaced by the prices predicted from the pre-shock relationship between tariff characteristics and monthly list prices. In Scenario 2, tariff prices remain as observed, but SIM-only tariffs are removed from the choice set. In Scenario 3, SIM-only tariffs are removed, and tariff prices are replaced by the predicted prices. Each scenario is compared with the observed baseline environment.

For each market environment, I recompute the predicted choice probabilities for each consumer and each available handset-tariff alternative. I then compute changes in consumer surplus using the procedure described in Section 5. Counterfactual simulations rely on the coefficients estimated in Model IV, reported in Table A.1.

In a first set of counterfactuals, I hold the attention weight γ at its estimated value by keeping the two price coefficients (α_1 and α_2) fixed at their estimates. Since γ is interpreted as a

[52] I take the launch of low-cost SIM-only brands, rather than the entry of the new operator, as the starting point of the price decline because this event initiated operators' pre-emptive pricing responses to the expected entry.

"revealed-choice" attention weight rather than as a preference parameter, the welfare changes across scenarios should be understood as changes in decision-weighted surplus under the attention environment estimated from observed choices. Importantly, I do not model how consumers' attention to future recurring charges would endogenously adjust if SIM-only tariffs were unavailable or if prices had followed the pre-shock hedonic price relationship.

In a second set of counterfactuals, I also simulate the same four market environments (i.e., the observed baseline and the three counterfactual scenarios) under a full-attention utility function. To do so, I impose $\gamma = 1$ by equating the coefficient on the present value of future costs with the coefficient on the upfront handset cost, so that $\alpha_2 = \alpha_1$. This changes the utility function used to predict choices: consumers are assumed to weight future recurring tariff payments one-for-one with the upfront handset cost. The full-attention exercise is therefore not an additional market counterfactual. It is a benchmark decision rule applied to the same baseline and counterfactual product environments. This distinction is important for interpretation. These eight situations[53] are comparable in terms of predicted choices and the characteristics of the chosen alternatives. Welfare comparisons, however, should be made only within a given utility specification. In other words, surplus changes under the estimated-γ utility function should be compared with the estimated-γ baseline, and surplus changes under the full-attention utility (i.e., when $\gamma = 1$) should be compared with the full-attention baseline. The welfare changes computed under the two utility specifications should not be interpreted as directly comparable to each other, as mentioned in Section 5.

The counterfactuals should be interpreted as within-operator simulations. As discussed in Section 4, the data come from a single operator, and I do not observe the full set of tariffs and handsets offered by rival operators at the individual level. I also do not observe consumers who would have subscribed to a competing operator under alternative market conditions. The simulations, therefore, hold fixed the set of consumers observed at the focal operator and reallocate them across the focal operator's products. They do not estimate a full-market equilibrium response, model rival operators' pricing reactions, or capture switching to or from competing

[53] That is, the observed baseline and three counterfactual scenarios under the estimated value of γ, and the observed baseline and three counterfactual scenarios under $\gamma = 1$.

operators. This limitation is particularly relevant after entry, when the outside option improved substantially. The resulting welfare changes should therefore be interpreted as conditional on subscribing to the focal operator, rather than as market-wide welfare effects.

A second limitation concerns substitution patterns. The counterfactual simulations are based on the preferred conditional logit specification and therefore inherit its substitution structure. Alternatives are handset-tariff combinations, and the model reallocates consumers across them based on estimated utility parameters and the logit substitution pattern. The welfare magnitudes should therefore be interpreted as conditional on the substitution patterns implied by the baseline model.

Counterfactual results Table A.2 reports the changes in consumer surplus associated with the three market scenarios, both under the estimated value of γ and under the full-attention benchmark, $\gamma = 1$. These surplus changes should be interpreted over the relevant contract or customer-relationship horizon, which is typically close to two years in this setting.

Under the estimated attention weights, removing the post-October-2011 decline in tariff prices while keeping SIM-only tariffs available reduces average consumer surplus by 58.98 euros. Removing SIM-only tariffs while keeping observed prices fixed reduces average consumer surplus by 23.25 euros. When both changes are removed simultaneously, namely when SIM-only tariffs are unavailable, and tariff prices are set according to the pre-shock pricing schedule, average consumer surplus falls by 85.04 euros. These results indicate that both observed market changes contributed to consumer welfare. The price decline accounts for the larger share of the simulated welfare gains, while the introduction of SIM-only tariffs provides an additional gain. The magnitude of the combined scenario is close to, but slightly larger than, the sum of the two separate effects. This suggests that the two market changes are complementary: lower tariff prices and the availability of SIM-only offers both improve consumers' choice environment, and removing both simultaneously generates the largest welfare loss.

The full-attention benchmark highlights similar qualitative patterns. When $\gamma = 1$, removing the post-October-2011 price decline reduces average consumer surplus by 89.72 euros, removing SIM-only tariffs reduces it by 42.71 euros, and removing both changes simultaneously reduces it

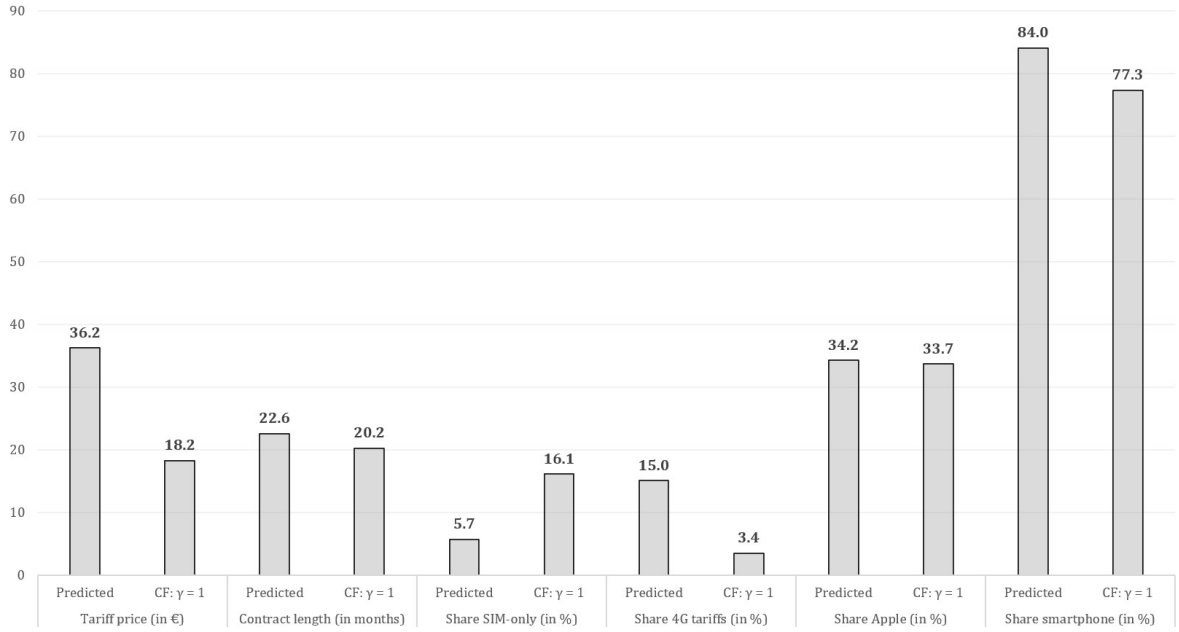
by 144.80 euros. Thus, within the full-attention benchmark, the price decline again accounts for the larger share of the simulated welfare gains, while SIM-only tariffs provide an additional gain through choice set expansion. The magnitudes are larger than under the estimated attention weights, which is consistent with the fact that, when future recurring payments are weighted one-for-one with upfront handset costs, changes in monthly tariff prices have a stronger effect on predicted surplus.

Table A.3 complements the welfare analysis by showing how the characteristics of predicted choices vary across the baseline and counterfactual environments. Under the estimated attention weights, the predicted baseline average tariff price is 36.21 euros. "Removing" the price decline increases the average selected tariff price to 40.58 euros, while removing SIM-only tariffs raises it only slightly, to 36.48 euros. Removing both changes leads to an average selected tariff price of 40.46 euros. The removal of SIM-only tariffs mechanically reallocates consumers toward tariffs with handsets: the predicted share of tariffs with handsets increases from 0.94 in the baseline to 1.00 when SIM-only tariffs are unavailable. Contract length also increases, from 22.58 months in the predicted baseline to 23.90 months when SIM-only tariffs are removed. This reflects the fact that, in the absence of SIM-only offers, consumers are reallocated toward bundled contracts, which are more often associated with longer commitment periods.

The full-attention simulations, also presented in Table A.3, illustrate how predicted choices change when consumers fully account for future recurring payments. In the observed product environment, imposing $\gamma = 1$ lowers the average selected tariff price from 36.21 euros under the estimated attention weights to 18.22 euros. It also increases the predicted share of SIM-only tariffs from 0.06 to 0.16 and reduces the average contract length from 22.58 to 20.24 months. These changes are consistent with the interpretation that underattention to future recurring payments leads consumers to select tariffs with higher monthly payments and longer commitments than they would choose under full attention.

The comparison of choice characteristics across the full-attention counterfactuals further reinforces this interpretation. When prices are predicted from the pre-October 2011 hedonic regression, but SIM-only tariffs remain available, the average selected tariff price under full

Figure 6: Predicted choices under estimated attention weights and full attention



Notes: The figure compares characteristics of predicted choices under the estimated attention weights with those obtained under a full-attention benchmark in which γ is set equal to one. Predictions are based on Model IV in Table A.1. The exercise should be interpreted as a within-operator prediction under the estimated substitution patterns, not as a full-market equilibrium simulation.

attention rises to 24.18 euros, and the predicted SIM-only share increases to 0.20. When SIM-only tariffs are removed, consumers are reallocated to tariffs with handsets, but the average selected tariff price remains much lower under full attention than under the estimated attention weights. Thus, the full-attention exercises suggest that the attention weight affects not only the level of predicted surplus changes within a given utility specification, but also the composition of predicted choices.

Figure 6 summarizes this comparison by contrasting predicted choices under the estimated attention weights with predicted choices under full attention. The figure highlights a key implication of the model: when future recurring payments receive full weight, consumers are predicted to choose lower monthly tariffs and, when available, SIM-only alternatives more frequently. It also shows that, under full attention, the share of consumers choosing an iPhone remains stable, while the share choosing a smartphone decreases.

Overall, the counterfactuals suggest that the observed market changes improved consumers' choice environment through two channels. The decline in tariff prices generates the largest simulated welfare gain, while the availability of SIM-only tariffs provides an additional, non-negligible gain. The full-attention benchmark highlights that consumer underattention also shapes predicted choices: when future payments are fully weighted, consumers move toward cheaper tariffs, shorter commitments, and, when available, SIM-only options.

8 Additional analyses and robustness checks

8.1 Additional analyses

Interaction of γ with SIM-only tariff shares As an alternative way to capture changes in the tariff environment, I re-estimate the main model by replacing the quarter interactions with the two price coefficients with interactions between these coefficients and the share of SIM-only tariffs available in the operator's catalog. This specification links the evolution of the attention weight more directly to changes in tariff variety, rather than to calendar time alone. Figure A.2 shows that the share of SIM-only tariffs available in the catalog increased sharply after the launch of low-cost SIM-only brands, reflecting the expansion of SIM-only variety in consumers' choice sets.[54]

The results of this specification are reported in Table OA.8. The interaction between the present value of future costs and the SIM-only catalog share is negative and statistically significant, while the corresponding interaction with the upfront handset cost is small and not statistically significant. As SIM-only tariffs become more prevalent in the choice set, consumers appear to become more sensitive to future recurring tariff payments, whereas their sensitivity to the upfront handset price remains little changed. Figure OA.6 shows the evolution of the attention weight implied by these estimates: γ increases with the share of SIM-only tariffs available in the catalog, consistent with the main results based on quarter interactions.[55]

[54] This measure is based on the supply of available tariffs, and not on the share of consumers choosing SIM-only contracts, so it is not mechanically linked to individual choices.

[55] This additional analysis should be interpreted as descriptive rather than causal, since SIM-only availability evolved alongside other market changes. However, it supports the interpretation that the rise in attention to future costs is related to changes in the tariff environment.

Additional socio-demographics and usage measures As described in Section 4, I use individuals' postcodes to merge additional municipality-level information into the data: population density, average fiscal income, and the unemployment rate. I interact these variables with the two price components and also allow price sensitivity to vary with observed voice and data usage. Results are presented in Table OA.9. The estimates point to additional heterogeneity in the price coefficients. Consumers living in denser municipalities and consumers with higher data usage are less sensitive to the upfront handset cost. Heavy voice and data users are more sensitive to the present value of future tariff payments. Importantly, allowing for these additional sources of heterogeneity does not affect the evolution of the attention weight γ, which remains very close to that obtained in the main specification.

8.2 Robustness checks

Alternative market interest rate and time horizon The computation of the present value of future costs relies on several assumptions regarding the market interest rate r and the time horizon S.

In the baseline specification, r is set equal to the average consumption-credit rate granted by banks, which is approximately 6% per year over the sample period. As discussed in Grigolon et al. (2018), however, the relevant rate could instead be interpreted as the opportunity cost of funds. I therefore consider two alternative assumptions. The low-interest-rate scenario uses the rate on regulated short-term bank deposits, which varies between 1% and 2.25% over the period. The high-interest-rate scenario uses the consumption-credit rate charged by specialized lenders offering revolving credit, which ranges between 12.8% and 15.2%. I recompute the present value of future tariff payments under these two alternative rates and re-estimate Model IV, presented in Table A.1. Results are reported in Table OA.10, and the implied attention weights are plotted in Figure OA.7. Both the level and the evolution of γ over time are almost unchanged, indicating that the main result is not driven by the particular interest rate used in the baseline computation.

The assumed payment horizon S has a more direct effect on the scale of the present value

of future payments. In the baseline specification, S varies across tariffs: it is set to 12 months for 12-month contracts, 24 months for 24-month contracts, and 19 months for no-commitment tariffs, corresponding to the average duration that non-committed consumers keep their tariff in the data. As a robustness check, I recompute the present value of future tariff payments using common horizons of 12, 24, and 32 months for all consumers. The corresponding estimates are reported in Table OA.11, and the implied values of γ are shown in Figure OA.8. These exercises highlight that the assumed horizon affects the level of the attention weight. When all consumers are assumed to consider only a 12-month horizon, γ ranges from about 0.92 at the beginning of 2011 to about 1.15 in the first quarter of 2013. This specification would imply little underweighting and even overweighting of future tariff payments in some periods. I view this scenario as implausible because it would require all consumers to expect to keep their tariff for only 12 months before switching or churning, whereas a large majority of consumers in the sample are committed to the operator for 24 months and cannot easily switch tariffs before the end of the commitment period.[56] By contrast, imposing a common 24-month horizon yields estimates that are very close to the baseline, especially at the beginning of the sample period, when most consumers choose 24-month contracts. Under this assumption, the attention weight ranges between about 0.46 and 0.67. Finally, the 32-month horizon corresponds to the case in which consumers evaluate future tariff payments over the expected lifetime of the handset rather than over the contractual horizon. This longer horizon mechanically increases the present value of future payments and therefore lowers the implied attention weight: γ ranges from about 0.34 in 2011 to about 0.55 by the end of 2014. Overall, these robustness checks show that the level of γ depends on the assumed payment horizon, but the upward trend over time persists across horizon assumptions.

Alternative samples of consumers Because the average estimated attention weight γ is strongly correlated with the share of SIM-only subscribers in the sample (correlation = 0.62), one may wonder whether the increase in attention to future expenses is entirely driven by the

[56]The fee paid by consumers who churn before the end of their contract is regulated by a national law since 2008. Switching may be possible before the end of the commitment period, but the rules are set by each operator and are not necessarily transparent to consumers.

growing number of consumers choosing SIM-only tariffs. To examine this issue, I estimate two alternative models on restricted samples. First, I restrict the sample to consumers who selected a contract with a commitment period of 12 or 24 months, either a SIM-only tariff or a traditional tariff with handset subsidy. This sub-sample includes 9,786 individuals out of the 10,738 individuals in the original sample. Computing γ for this group is useful because the relevant payment horizon is directly observed, which relaxes the assumption that S equals 19 months for non-committed consumers. Second, I restrict the sample to consumers who chose a tariff with a handset subsidy. This sub-sample consists of 8,974 individuals who selected a handset from the operator's catalog and were committed for either 12 or 24 months. This exercise also removes the need to assume the payment horizon of non-committed consumers and allows me to examine how attention to future costs evolved among consumers choosing traditional, subsidized-handset contracts.

The implied values of γ from these alternative estimations are shown in Figure OA.9. The estimated attention weight is, on average, lower among consumers who selected committed contracts and among consumers who selected tariffs with handset subsidies, which is intuitive. However, a clear increase in γ over time is still observed in both restricted samples. While the main-sample estimates suggest that γ was multiplied by about 1.6 between 2011 and 2014, it was multiplied by roughly 1.5 among consumers with committed contracts and among consumers choosing tariffs with handset subsidies. These results indicate that the increase in attention to future expenses is not driven solely by the growing share of SIM-only subscribers in the sample: the same evolution remains visible when non-committed consumers are excluded, and when the analysis is further restricted to consumers choosing traditional tariffs. This supports the interpretation that the market changes affected the weight consumers placed on future expenses broadly.

Alternative time samples In the telecommunications industry, product characteristics evolve relatively quickly. As a result, consumers' valuation of these characteristics may also change over time. In the main specification, I assume that most of these valuations are stable over the sample period. I relax this assumption by estimating the model separately by year and by quarter.

Results from the year-level regressions are reported in Table OA.12. The corresponding estimates of γ are shown in Figure OA.10 for the year-level regressions and in Figure OA.11 for the quarter-level regressions. Both analyses support the robustness of the main result: the estimated attention weight γ increases substantially over the period.

Alternative choice set construction Because consumers face a very large number of possible tariff-handset combinations, the construction of individual choice sets requires sampling among available alternatives. I first evaluate the sensitivity of the results by increasing the size of the sampled choice sets, while reducing the number of individuals used in the estimation to keep the dataset computationally manageable. The results are presented in Table OA.13. Overall, the estimates are stable and differ only marginally from the main specification, except in the full-choice set case, which is estimated on a much smaller sample of only 250 consumers. Figure OA.12 shows that the implied estimates of γ are not statistically different across choice set sizes, again with the exception of the full-choice set specification. Given the very small number of individuals included in that regression, these estimates should be interpreted with caution.

I then conduct additional robustness checks using alternative sampling methods. In the main specification, choice sets are constructed by randomly sampling available handsets and available tariffs separately, and then combining them. As a first alternative, I draw 400 random tariff-handset combinations directly. I also consider a weighted version of this combination-level sampling procedure in which combinations involving Apple handsets are drawn with higher probability, since Apple products are somewhat under-represented under purely random sampling and play an important role in handset choice; this specification also uses 400 randomly sampled combinations.[57] Finally, I use a more restrictive procedure that samples tariff-handset combinations similar to the chosen alternative, yielding on average 332 sampled alternatives per consumer.[58] Table OA.14 reports the results obtained with these alternative choice set construc-

[57] In the original choice set construction, Apple handsets are not under-represented for consumers who chose an Apple handset. This is because the chosen handset is always included in the sampled choice set and is combined with several tariffs. As a result, for Apple buyers, the selected Apple handset appears in multiple alternatives, typically with at least 10 different tariffs.

[58] In this case, I randomly select tariff-handset combinations with attributes similar to those of the chosen alternative: the same handset and allowance ranges when possible; otherwise, the same brand, handset price range, and allowance ranges, and so on. The resulting number of sampled alternatives varies across consumers

tions. Figure OA.13 shows the corresponding evolution of γ over time. The estimates remain very similar across sampling procedures, indicating that the main results are not driven by the particular way in which the sampled choice sets are constructed.

Fixed effects approach An alternative way to address price endogeneity is to include product fixed effects, as discussed in Section 5. This approach would absorb persistent unobserved quality at the tariff and handset level, and, therefore, relies less directly on the excluded cost shifters used in the control-function specification.

In principle, one could include fixed effects for all tariffs and handsets. In practice, this is not desirable in the present setting because the number of products is large, and many tariffs and handsets are selected only a few times.[59] I therefore introduce fixed effects for the 200 most frequently selected tariffs and the 200 most frequently selected handsets.[60] These products account for approximately 65% of observed choices in the sample: 64.16% of selected tariffs and 69.80% of selected handsets. Products outside this group are still accounted for through their observed characteristics and, for handsets, through brand and technical attributes. I also include handset-brand interactions with time, which allow the average quality or "attractiveness" of brands to evolve over the sample period.[61]

Table OA.15 reports the results obtained with this approach. Column 1 introduces fixed effects for the 200 most frequently selected handsets, Column 2 introduces fixed effects for the 200 most frequently selected tariffs, and Column 3 includes both sets of product fixed effects. Column 4 further adds handset-brand dummies interacted with time. In these specifications, I do not include the residuals from the first stage price regressions, as the product fixed-effects approach serves as an alternative to the control-function correction. The main price coefficients

because the number of close available combinations differs across consumers.

[59] Fixed effects for rarely chosen products would be imprecisely estimated and would substantially increase the number of parameters without capturing meaningful additional variation.

[60] This threshold is necessarily pragmatic, but it is chosen to cover a large share of observed choices while keeping the number of additional parameters manageable.

[61] The results are not sensitive to the exact number of product fixed effects included. Additional specifications that include fixed effects for only the 50 or 100 most frequently selected tariffs and handsets yield very similar estimates, especially for the two price coefficients. I report the specification with 200 tariff and 200 handset fixed effects as a conservative implementation, since it absorbs unobserved quality for a broader set of commonly chosen products.

remain very stable across the product fixed-effects specifications: the coefficient on the present value of future costs ranges from −0.003 to −0.002, while the coefficient on the upfront handset cost ranges from −0.010 to −0.009.

I also report, in Table OA.16, results from specifications that combine product fixed effects with the control-function correction. This table compares three approaches: the control-function specification, which is the main specification used in the paper; the most complete product fixed-effects specification, already reported in Table OA.15; and the combined specification. For the present value of future costs, the main coefficient is −0.003 in the control-function specification and −0.002 when product fixed effects are included. For the upfront handset cost, the coefficient remains equal to −0.009 across specifications. The coefficients on tariff and handset attributes change somewhat in magnitude, as expected when additional product-level controls are included, but remain qualitatively similar overall. These baseline price coefficients suggest that the product fixed-effects approach may imply a lower level of the attention weight than the control-function approach. Consistent with this, Figure OA.14 shows that the level of the attention weight is lower under the fixed-effects specification, while its evolution over time remains very similar.

Random coefficients approach The main model is estimated using a conditional logit and therefore has the standard limitation of this class of models: it imposes proportional substitution across alternatives.[62] I use a mixed logit specification as a robustness check that partially relaxes the substitution pattern imposed by the baseline model.[63]

While the conditional logit specification captures systematic taste variation through inter-

[62]This restriction is particularly relevant here because alternatives are handset-tariff combinations, so that two alternatives may share the same handset, the same tariff, or the same tariff type. A nested-logit specification would be one way to allow for correlation in unobserved utility across related alternatives. In the present setting, however, the natural nests overlap across several dimensions. A single non-overlapping nesting structure would require choosing one dimension of similarity, such as handset model, handset brand, or tariff type, while ignoring the others. An overlapping-nest structure would be conceptually closer to the choice environment, but would be computationally impractical with individual-level choice sets containing several hundred alternatives.

[63]This approach is consistent with the broader discrete choice literature, which treats nested logit and random-coefficients logit as alternative ways of introducing richer substitution patterns. Grigolon and Verboven (2014) show that random-coefficients and nested-logit models capture different sources of consumer heterogeneity, and that random-coefficients models can approximate nested-logit-type substitution patterns in some settings. They also emphasize, however, that discrete sources of market segmentation may still matter. I therefore do not interpret the mixed logit specification as a full substitute for an overlapping-nest model, but rather as a robustness check that relaxes the most restrictive feature of the baseline conditional logit.

actions with age, gender, and time of subscription, it does not allow for additional random taste variation across consumers. I therefore re-estimate the main model by allowing random coefficients on the two price variables: the upfront handset cost and the present value of future tariff payments.[64] The results are presented in Table OA.17. The main coefficients remain close to those obtained in the conditional logit specification: the coefficient on the present value of future costs changes from -0.003 in the conditional logit to -0.004 in the mixed logit, while the coefficient on the upfront cost remains equal to -0.009 in both specifications.

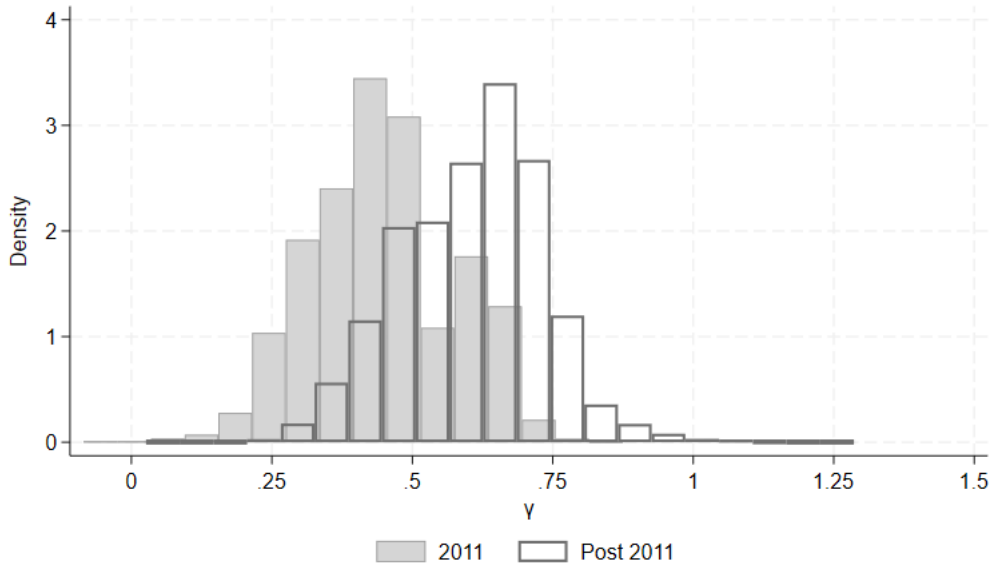
The estimated standard deviations of the random coefficients indicate limited additional heterogeneity in sensitivity to the upfront handset cost, but more substantial heterogeneity in sensitivity to the present value of future tariff payments. This is visible in Figures OA.15 and OA.16. The first figure shows the distribution of the price coefficients before adding interactions with time, age group, and gender; the second shows the corresponding price coefficients after including these interactions. I then compute individual-level values of γ using the individual coefficients for the upfront cost and the present value of future costs, combining the random coefficients with the interactions by age group, gender, and month of subscription. Figure OA.17 presents the resulting distribution of γ.

I now report two additional figures that show how this distribution varies across key dimensions: over time, around the entry period, and by the type of tariff selected. Figure 7 shows how the distribution of individual-level γ changes before and after 2012. The distribution shifts toward higher values after 2012, indicating that the decline in myopia (or equivalently, the increase in the attention weight) documented in the baseline model remains visible when additional unobserved heterogeneity in price sensitivity is allowed.

Figure OA.18 shows how the distribution of the attention weight γ differs across consumers according to the type of tariff they selected. The distribution for consumers who chose a SIM-only tariff is shifted to the right relative to the distribution for consumers who chose a tariff bundled with a handset. This is consistent with the interpretation, developed throughout the paper, that consumers selecting SIM-only tariffs are more attentive to the recurring-price dimension of the contract.

[64] I use the command `mixlogit` for Stata (Hole, 2007). I use 100 Halton draws.

Figure 7: Distribution of attention weight computed with random coefficients



Notes: The figure reports the distribution of γ obtained from the mixed logit robustness specification, which allows for random coefficients on the upfront handset cost and the present value of future recurring costs. The corresponding estimation results are reported in Column 2 of Table OA.17. Individual attention weights are computed from the coefficients on upfront and future costs, including their interactions with subscription quarter, age group, and gender.

9 Conclusion

In this paper, I study consumer choices in a market where products combine an upfront handset payment with future recurring tariff payments. I estimate discrete choice models for 10,738 consumers choosing a mobile tariff and a handset between 2011 and 2014, and use the estimates to compute an *attention weight*. This weight measures the extent to which future recurring charges affect observed choices relative to the upfront handset cost. I interpret values below one as evidence of underattention to future costs, or choice-based myopia.

The results show that consumers place less than full weight on future payments, but that this underweighting declines substantially over the sample period. The increase in the attention weight coincides with major changes in the market environment: the diffusion of SIM-only tariffs, the entry of a new competitor, a general decline in tariff prices, and increased transparency regarding the total cost of subsidized-handset contracts. The evidence suggests that these market

changes increased the attention weight for consumers choosing SIM-only tariffs, as well as for those choosing bundled tariffs with handsets. The observed evolution is therefore not simply driven by the mechanical growth in the share of SIM-only subscribers. It is more consistent with a broader change in how consumers evaluate the trade-off between upfront handset payments and future tariff payments.

The results from the counterfactual simulations suggest that the observed market changes improved consumers' choice environment through two channels. First, the decline in tariff prices accounts for the larger share of the simulated gains in consumer surplus. Second, the availability of SIM-only tariffs provides an additional gain by expanding the choice set and allowing consumers to separate handset acquisition from mobile-service subscription. The full-attention benchmark further shows that underattention shapes predicted choices. When future recurring payments are given full weight, consumers are expected to choose lower monthly tariffs, shorter commitments, and, when available, SIM-only alternatives more frequently.

This study makes two main contributions. First, it uses individual-level choices to estimate how consumers weigh future recurring payments relative to upfront costs, and to quantify heterogeneity across consumer groups and over time. Relative to existing work, the paper allows the attention weight to vary over time and relates this evolution to changes in market conditions, namely tariff variety and price transparency. Second, it contributes to the small literature on intertemporal choice frictions in mobile telecommunications. My paper complements it by studying the joint choice of handsets and tariffs and by estimating an attention weight on future recurring payments in a setting where handset subsidies create a direct trade-off between upfront and future payments.

The findings have implications for policy. In markets where consumers face intertemporal price structures, such as products or contracts that combine upfront payments with recurring charges, consumer protection cannot be evaluated solely by price levels or product variety. The way prices are framed, bundled, and made comparable may also matter. In the setting studied in this paper, the role of SIM-only tariffs went beyond expanding the product menu: by separating mobile service from handset acquisition, they made the service component more transparent and

the implicit cost of handset subsidies easier to evaluate. This suggests that policies or market designs that improve the transparency and comparability of upfront and recurring payment components may affect choices by changing how consumers evaluate intertemporal trade-offs. More broadly, the results reinforce the importance of measuring consumers' perceptions of future costs when evaluating policy in markets with intertemporal trade-offs. Evidence from technology adoption and subsidy design shows that underweighting future costs or benefits can affect both consumer choices and the relative efficiency of policy instruments (e.g., De Groote and Verboven, 2019).

The implications for firms are more ambiguous. Greater consumer attention to future recurring payments may reduce firms' ability to extract rents through complex pricing or handset subsidies. It may also weaken handset subsidization as a tool for fostering the adoption of new devices and services, such as smartphones or mobile data. At the same time, handset subsidies require operators to finance expensive devices upfront, which can be costly, especially for smaller competitors. A market environment in which consumers better understand the trade-off between handset upfront prices and recurring charges may therefore make pricing more transparent, while also affecting firms' incentives to subsidize handsets, finance devices, or compete through alternative pricing schemes. Finally, more transparent contracts may also affect the quality of the consumer-operator relationship. Handset subsidies can generate contractual lock-in (OECD, 2013), but this form of retention does not necessarily reflect consumer satisfaction. When the total cost of a contract is difficult to evaluate, consumers may be more likely to feel dissatisfied ex post and to search for alternative offers once switching becomes possible. By contrast, consumers who enter contracts with a clearer understanding of total costs may be more satisfied with their choices, potentially supporting more stable relationships with operators in the longer run.

Overall, these results suggest that changes in market conditions can affect how consumers evaluate intertemporal trade-offs, with implications for consumer welfare and firms' pricing strategies.

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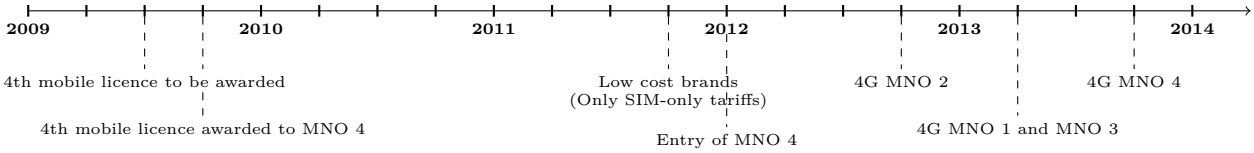
Appendix: Main figures and tables

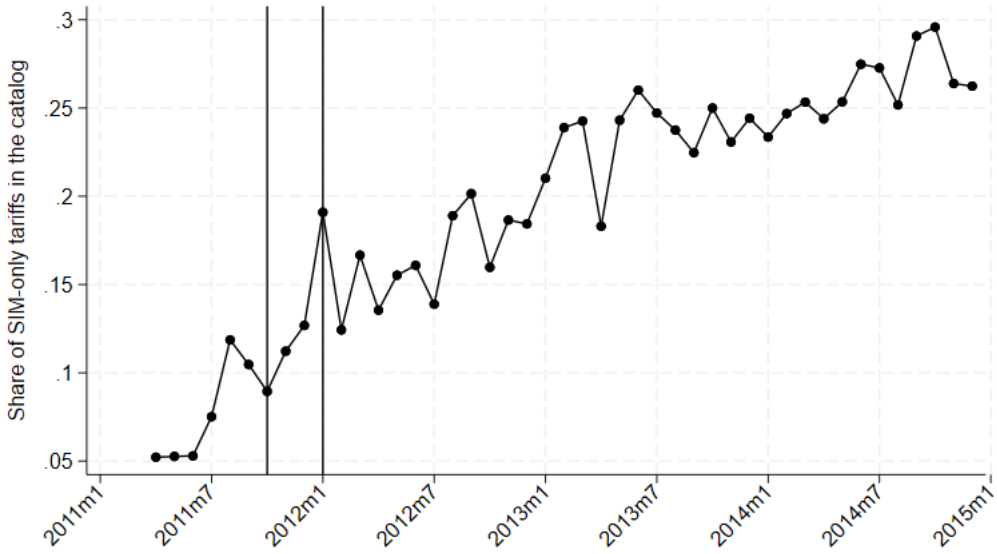
A.1 Industry background

Figure A.1: Timeline of entry and launch of 4G services in the focal country



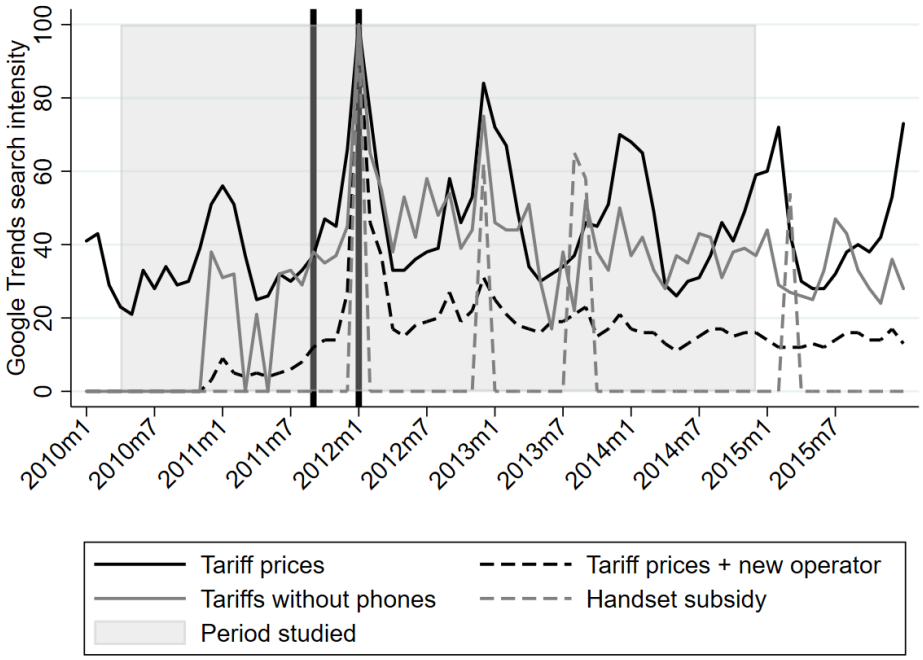
Notes: The timeline summarizes the main market events used to interpret the evolution of consumer attention: the launch of low-cost SIM-only tariffs, the entry of the fourth MNO, and the rollout of 4G services. *MNO* abbreviates Mobile Network Operator. *4G* corresponds to the introduction of LTE services by mobile operators.

Figure A.2: Share of SIM-only tariffs in the focal operator's catalog



Notes: The figure reports the monthly share of available tariffs in the focal operator's catalog that are SIM-only, i.e., tariffs not bundled with a handset. This is a supply-side measure of product availability, not the share of consumers choosing SIM-only tariffs. The vertical lines mark the launch of low-cost SIM-only brands by incumbent operators and the entry of the new mobile network operator.

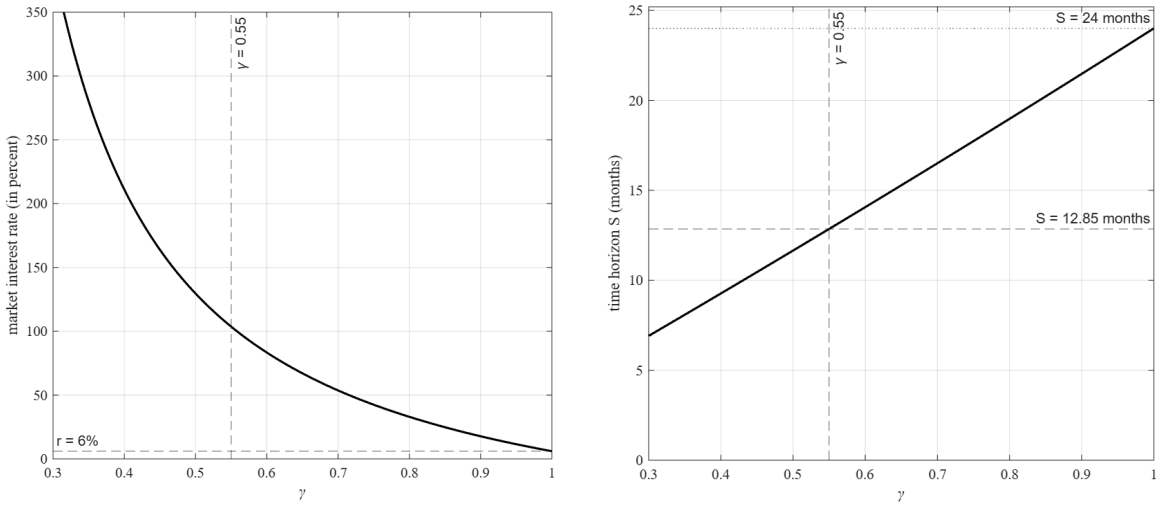
Figure A.3: Google Trends search intensity (2010-2016) for selected keywords



Notes: The figure reports monthly Google Trends search intensity for anonymized terms related to mobile tariff prices, SIM-only tariffs, the new operator, and handset subsidies. The series are normalized Google Trends indices: 100 corresponds to the peak search intensity observed in the focal country over the period, while 0 indicates that search volume was too low to be reported in a given month. Values, therefore, measure relative search intensity within the selected country and period, rather than absolute search volumes. The vertical lines mark the introduction of low-cost SIM-only tariffs and the entry of the new mobile operator. Keyword sets are translated from the original language into English for display purposes. "New Operator" corresponds to the name of the new operator entering the market in 2012 (MNO 4).

A.2 Attention weight, market interest rate, and time horizon

Figure A.4: Relationship between γ, r and S



Notes: The figures illustrate the relationship between the attention weight γ and the two parameters used to compute the present value of future recurring payments: the market interest rate r and the time horizon S. The figure on the left shows the annual interest rate that would be required to make the estimated trade-off between upfront and future payments consistent with full attention, under a 24-month horizon. The dashed lines indicate the illustrative value $\gamma = 0.55$, and the dotted line indicates the benchmark market interest rate used in the paper, $r = 6\%$. The figure on the right shows the payment horizon that would be required to make the same trade-off consistent with full attention, holding the market interest rate fixed at its benchmark value of 6%. The vertical dashed line indicates the illustrative value $\gamma = 0.55$, while the horizontal dotted line marks a 24-month horizon. The horizontal dashed line shows that, for a horizon of about 13 months ($S = 12.85$), an attention weight of 0.55 would be consistent with full attention. I am grateful to an anonymous referee for suggesting these computations and figures.

The figure on the left shows the annual interest rate that would be required for the estimated trade-off between upfront and future payments (γ) to be consistent with full attention, holding fixed a 24-month payment horizon. For values of γ close to the main estimates, around 0.55, the implied annual interest rate is extremely high, roughly between 100% and 130%. These values are far above the market interest rate used in the baseline specification and the alternative rates considered in the robustness checks. This exercise therefore suggests that the finding $\gamma < 1$ is unlikely to be driven by the benchmark interest-rate assumption alone.

The figure on the right performs a similar exercise for the payment horizon, holding the market interest rate fixed at its benchmark value. It shows that the horizon needed to rationalize full attention is much more sensitive to the value of γ: for example, an attention weight around

0.55 corresponds to a horizon close to 13 months. This figure, therefore, highlights why assumptions about S are more important for the level of γ than assumptions about r. In the baseline specification, S varies across tariff types and equals 24 months for the majority of consumers; Section 8.2 therefore reports robustness checks using alternative common horizons.

A.3 Main estimation results

Table A.1: Main estimation results on determinants of consumers' choices

Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)		(4)	
Estimation method: Conditional logit	Model I		Model II		Model III		Model IV	
Prices								
Upfront cost of handset (α_1)	-0.008***	(0.00)	-0.009***	(0.00)	-0.009***	(0.00)	-0.009***	(0.00)
Present value of future costs (α_2)	-0.003***	(0.00)	-0.003***	(0.00)	-0.003***	(0.00)	-0.003***	(0.00)
Tariff characteristics								
Data allowance								
500 MB=1	1.152***	(0.03)	1.141***	(0.03)	1.131***	(0.03)	1.142***	(0.03)
1 GB=1	1.888***	(0.05)	1.853***	(0.05)	1.708***	(0.05)	1.727***	(0.05)
2 GB=1	1.947***	(0.05)	1.898***	(0.05)	1.980***	(0.05)	2.012***	(0.05)
4 GB=1	1.621***	(0.06)	1.560***	(0.06)	1.837***	(0.07)	1.878***	(0.07)
10 GB=1	2.502***	(0.10)	2.371***	(0.11)	2.969***	(0.13)	3.046***	(0.13)
Unlimited calls=1	0.912***	(0.04)	0.850***	(0.06)	1.187***	(0.06)	1.226***	(0.06)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.00)	0.002***	(0.00)	0.002***	(0.00)	0.002***	(0.00)
Fixed broadband=1	1.579***	(0.05)	1.591***	(0.05)	1.789***	(0.05)	1.813***	(0.05)
SIM-only no commitment	-0.650***	(0.04)	-0.494***	(0.04)	-0.704***	(0.04)	-0.718***	(0.04)
SIM-only 12 months contract	-2.646***	(0.05)	-2.488***	(0.06)	-2.878***	(0.06)	-2.907***	(0.06)
SIM-only, 24 months contracts	-1.787***	(0.07)	-1.614***	(0.07)	-1.732***	(0.07)	-1.739***	(0.07)
Tariff with handset, 12 months contract	-4.106***	(0.05)	-4.144***	(0.05)	-4.334***	(0.06)	-4.345***	(0.05)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Handset characteristics								
Dummy Apple	6.494***	(0.07)	6.879***	(0.07)	6.909***	(0.07)	6.864***	(0.08)
Dummy BlackBerry	2.509***	(0.06)	2.861***	(0.06)	2.888***	(0.06)	2.897***	(0.06)
Dummy HTC	-0.154	(0.09)	0.016	(0.09)	0.025	(0.09)	0.038	(0.09)
Dummy LG	-0.167*	(0.07)	-0.124	(0.07)	-0.112	(0.07)	-0.110	(0.07)
Dummy Motorola	-0.099	(0.12)	-0.086	(0.13)	-0.066	(0.13)	-0.053	(0.13)
Dummy Nokia	1.006***	(0.05)	1.011***	(0.05)	1.007***	(0.05)	1.013***	(0.05)
Dummy Samsung	1.539***	(0.05)	1.612***	(0.05)	1.633***	(0.05)	1.643***	(0.05)
Dummy smartphone=1	1.208***	(0.04)	1.243***	(0.04)	1.211***	(0.04)	1.241***	(0.04)
Handset age (months)	0.011***	(0.00)	-0.007***	(0.00)	-0.007***	(0.00)	-0.007***	(0.00)
Height	0.018***	(0.00)	0.018***	(0.00)	0.019***	(0.00)	0.019***	(0.00)
Width	0.008*	(0.00)	-0.006	(0.00)	-0.008*	(0.00)	-0.006*	(0.00)
Thickness	0.045***	(0.01)	0.056***	(0.01)	0.058***	(0.01)	0.059***	(0.01)
Camera quality (MP)	0.081***	(0.01)	0.098***	(0.01)	0.102***	(0.01)	0.102***	(0.01)
Battery standby time (hours)	0.002***	(0.00)	0.002***	(0.00)	0.002***	(0.00)	0.002***	(0.00)
LTE × 4G tariff	1.316***	(0.07)	1.196***	(0.07)	1.284***	(0.07)	1.259***	(0.07)
Control functions								
Residuals from handset price regression			0.005***	(0.00)	0.006***	(0.00)	0.006***	(0.00)
Residuals from tariff price regression			-0.002	(0.00)	0.005***	(0.00)	0.006***	(0.00)
Interactions of prices with time					Yes		Yes	
Interactions of prices with consumer characteristics							Yes	
Observations	3,851,776		3,851,776		3,851,776		3,851,776	
Number of consumers	10,738		10,738		10,738		10,738	
Log likelihood	-4.55e+04		-4.51e+04		-4.46e+04		-4.42e+04	

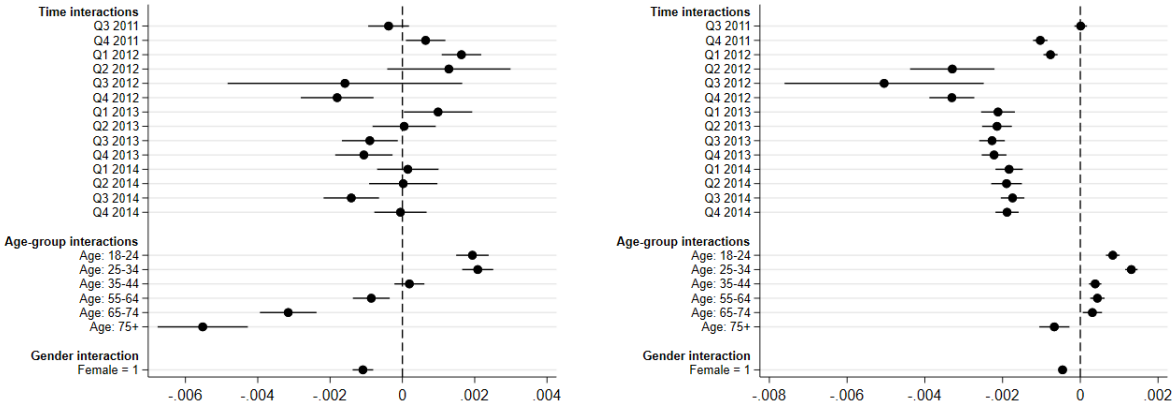
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: All columns report estimates from a conditional logit model in which alternatives are handset-tariff combinations. The specifications progressively add control functions and heterogeneity in the price coefficients. Model IV is the preferred specification: it corrects for price endogeneity and allows the coefficients on the two price coefficients (i.e., upfront handset costs and the present value of future recurring costs) to vary by subscription quarter, age group, and gender. The base categories are Q2 2011 for subscription quarters, ages 45-54 for age groups, and male for gender. The control functions are the residuals from the first stage tariff-price and handset-price regressions reported in Tables OA.6 and OA.5, respectively.

Figure A.5: Interactions of price coefficients

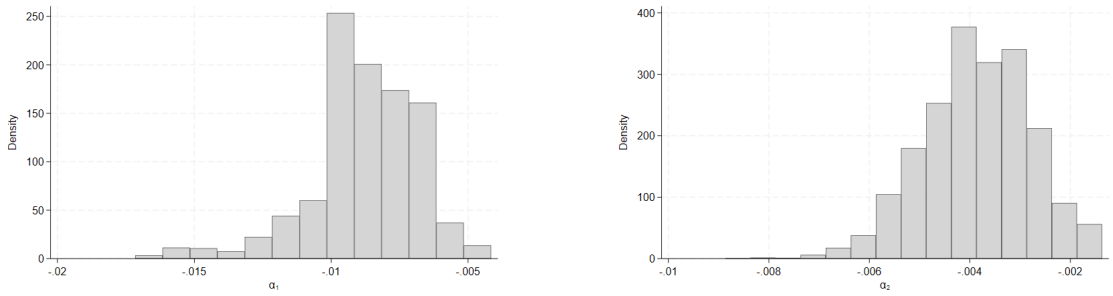
Upfront cost α_1 | Present value of future costs α_2



Notes: The figure reports the estimated interactions between the two price coefficients and subscription quarter, age group, and gender in Model IV of Table A.1. These estimates are used to construct the individual- and time-specific coefficients on upfront handset costs and the present value of future recurring costs, and therefore the corresponding values of γ.

Figure A.6: Price coefficients for upfront and future costs

Upfront cost α_{1it} | Present value of future costs α_{2it}



Notes: The figure reports the distribution of individual-level price coefficients obtained with Model IV in Table A.1. The coefficients are computed for the 10,738 individuals in the estimation sample by combining the baseline coefficients with the subscription-quarter, age-group, and gender interactions. They are then used to compute the attention weight γ.

A.4 Counterfactuals

Table A.2: Counterfactual effects on prices and consumer surplus

	Characteristics of alternatives		Δ Consumer Surplus			
	Tariff price	% of SIM-only	Estimated γ		$\gamma = 1$	
	Mean	Mean	Mean	Std. dev.	Mean	Std. dev.
Baseline	41.22	0.35	0.00	0.00	0.00	0.00
Scenario 1	49.44	0.35	-58.98	69.04	-89.72	117.68
Scenario 2	44.06	0	-23.25	23.35	-42.71	38.62
Scenario 3	52.32	0	-85.04	89.54	-144.80	158.72

Notes: The table reports average tariff prices, the share of SIM-only tariffs in consumers' choice sets, and changes in consumer surplus under the different counterfactual scenarios. Predictions are computed for the 10,738 consumers in the estimation sample. Changes in consumer surplus are measured relative to the baseline situation, in which prices are observed and SIM-only tariffs are available. Scenario 1 keeps SIM-only tariffs available but sets prices according to the predicted values from the pre-October 2011 hedonic regression. Scenario 2 removes SIM-only tariffs while keeping prices as observed. Scenario 3 removes SIM-only tariffs and sets prices at their pre-October 2011 level. Results are reported under the estimated attention weights (Columns 4 and 5) and under full attention, $\gamma = 1$ (Columns 6 and 7).

Table A.3: Observed, predicted, and counterfactual characteristics of selected alternatives

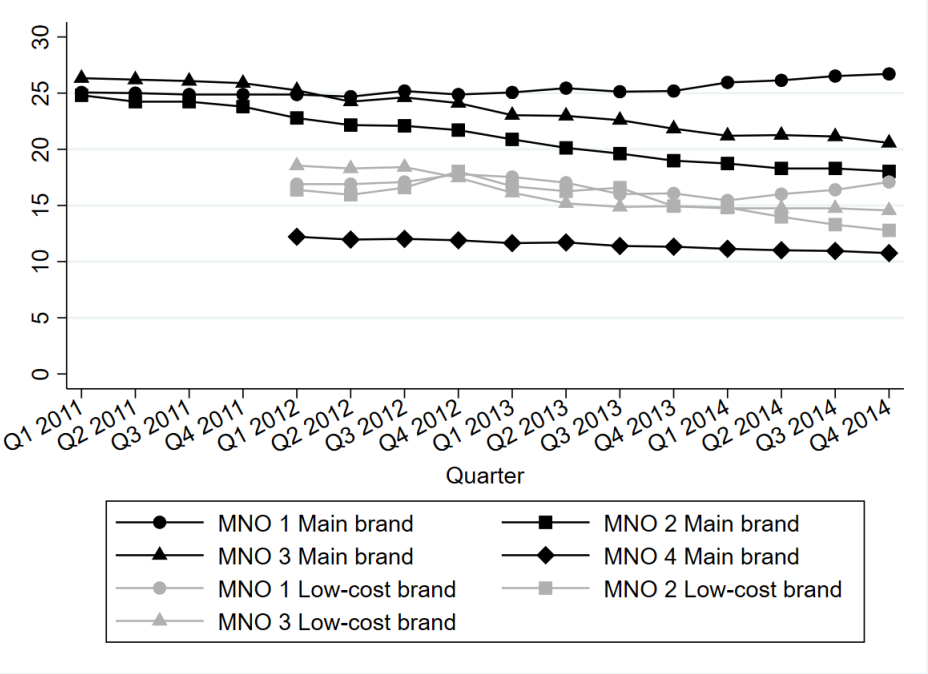
	Baseline		Counterfactuals						
		With estimated γ	With estimated γ			With $\gamma = 1$			
	Observed	Predicted	Scen. 1	Scen. 2	Scen. 3	Predicted*	Scen. 1	Scen. 2	Scen. 3
Tariff price	34.41	36.21	40.58	36.48	40.46	18.22	24.18	18.70	25.61
Tariff with handset (0/1)	0.84	0.94	0.95	1.00	1.00	0.84	0.80	1.00	1.00
SIM-only tariff (0/1)	0.16	0.06	0.05	0.00	0.00	0.16	0.20	0.00	0.00
Contract length	20.53	22.58	22.54	23.90	23.61	20.24	19.54	23.98	23.49
4G tariff (0/1)	0.10	0.15	0.09	0.14	0.08	0.03	0.03	0.02	0.04
Smartphone (0/1)	0.72	0.84	0.85	0.84	0.85	0.77	0.79	0.77	0.80
Apple (0/1)	0.25	0.34	0.34	0.34	0.34	0.34	0.34	0.33	0.33

Notes: The table compares observed choices, predicted choices, and counterfactual choices across key characteristics. "Scen." denotes scenario. Scenario 1 keeps SIM-only tariffs available but sets prices according to the predicted values from the pre-October 2011 hedonic regression. Scenario 2 removes SIM-only tariffs while keeping prices as observed. Scenario 3 removes SIM-only tariffs and sets prices at their pre-October 2011 level. *Predicted choices (with $\gamma = 1$) are computed using the baseline price environment, i.e., observed prices. For Scenarios 2 and 3, SIM-only prices are treated as missing when computing average prices in this table, since SIM-only alternatives are unavailable to consumers in these scenarios.

Online Appendix

OA.1 Single-operator data and representativeness

Figure OA.1: Average prices observed at the national level



Data source: International Data Corporation (IDC)

Notes: The figure compares average tariff prices for the focal operator and other mobile network operators using IDC data. The data used in the paper come from Mobile Network Operator 1 and cover subscribers to both its main brand and its low-cost brand. The figure is used as a representativeness check, showing how closely the focal operator's price path tracks broader market prices. Average prices are relatively comparable across established operators (MNOs 1, 2, and 3), although differences between main-brand prices increase somewhat after 2013. Prices of the low-cost brands remain very close in levels. The entrant, MNO 4, is clearly positioned at lower prices.

Table OA.1: Comparison of handset characteristics in the estimation and IDC samples

	IDC Sample					Sample used in the paper				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Handset list price (in euros)	185	220	154	18	737	314	259.53	168.37	16.5	769.9
Smartphone dummy	185	0.72	0.45	0.0	1.0	314	0.64	0.48	0.0	1.0
LTE dummy	185	0.24	0.43	0.0	1.0	314	0.21	0.41	0.0	1.0
Age handset (in months)	185	9.17	8.52	0.0	68.0	314	15.80	10.78	0.0	52.1
Height	185	119.91	15.73	87.0	179.0	314	116.99	15.23	67.0	172.0
Width	185	60.65	9.57	43.0	92.0	314	59.35	8.60	44.0	85.9
Thickness	185	11.60	2.68	6.2	20.7	314	11.95	2.89	6.7	23.0
Camera quality (in MP)	185	5.81	5.05	0.0	41.0	314	4.90	4.47	0.0	41.0
Dummy Apple	185	0.03	0.18	0.0	1.0	314	0.03	0.16	0.0	1.0
Dummy Samsung	185	0.05	0.22	0.0	1.0	314	0.26	0.44	0.0	1.0
Dummy Android	185	0.41	0.49	0.0	1.0	314	0.44	0.50	0.0	1.0
Dummy iOS	185	0.03	0.18	0.0	1.0	314	0.03	0.16	0.0	1.0
Dummy Windows OS	185	0.00	0.00	0.0	0.0	314	0.06	0.24	0.0	1.0
Dummy BlackBerry OS	185	0.00	0.00	0.0	0.0	314	0.05	0.21	0.0	1.0

Notes: The table compares handset characteristics in the IDC handset sample with the handsets used in the estimation sample. It is used as a coverage check to determine whether the estimation sample spans a plausible range of handset prices and technical characteristics. The two samples cover similar price ranges, from about 17 euros to about 750 euros. Average handset prices are somewhat lower in the IDC sample, and IDC handsets are more recent on average, with an average age of about 9 months compared with about 16 months in the estimation sample.

OA.2 Descriptive statistics

Table OA.2: Summary statistics by year

	2011	2012	2013	2014
Tariff price	37.11	32.03	29.56	32.55
Handset list price	377.9	359.4	327.3	323.4
individuals with handset	375.9	352.7	343.2	356.0
individuals with no handset	433.5	379.6	297.7	260.1
Amount of subsidy (if >0)	244.3	235.2	192.3	173.7
Upfront cost of handset	142.1	183.0	205.2	229.4
individuals with handset	131.6	117.8	155.7	213.6
individuals with no handset	433.5	379.6	297.7	260.1
Share of SIM-only	3.5	24.9	34.9	34.0
Contract length				
0	0.8	18.0	18.7	15.9
12	7.4	7.7	21.1	20.4
24	91.8	74.4	60.3	63.7
Share of observations	51.8	20.4	13.4	14.4
Individuals	5,566	2,193	1,434	1,545

Table OA.3: Observable characteristics of subscribers and choices by subscription cohort

	Female	Age	Calls	Data usage	Smartphone	Apple	Samsung	N
Q2 2011	0.50	44.58	68.09	0.09	0.64	0.22	0.34	1 580
Q3 2011	0.53	43.63	66.04	0.11	0.70	0.23	0.34	2 079
Q4 2011	0.52	43.37	57.74	0.10	0.75	0.31	0.30	1 907
Q1 2012	0.48	44.85	61.15	0.09	0.70	0.21	0.40	1 901
Q2 2012	0.62	47.14	81.40	0.14	0.48	0.22	0.26	65
Q3 2012	0.24	43.71	86.01	0.08	0.53	0.18	0.41	17
Q4 2012	0.50	37.08	149.79	0.12	0.50	0.20	0.40	210
Q1 2013	0.49	41.69	103.63	0.15	0.58	0.31	0.26	236
Q2 2013	0.52	40.53	136.42	0.27	0.67	0.34	0.25	301
Q3 2013	0.52	42.40	106.77	0.36	0.75	0.26	0.29	451
Q4 2013	0.53	39.15	166.98	0.42	0.79	0.26	0.33	446
Q1 2014	0.50	40.12	150.70	0.57	0.78	0.23	0.34	352
Q2 2014	0.54	41.11	127.76	0.59	0.80	0.29	0.29	253
Q3 2014	0.54	40.94	114.27	0.94	0.88	0.30	0.30	427
Q4 2014	0.51	39.68	127.61	0.89	0.92	0.33	0.27	513
SIM-only	0.45	43.62	82.90	0.23	0.67	0.30	0.30	1764
Handset with subsidy	0.52	42.87	83.69	0.23	0.73	0.24	0.34	8974

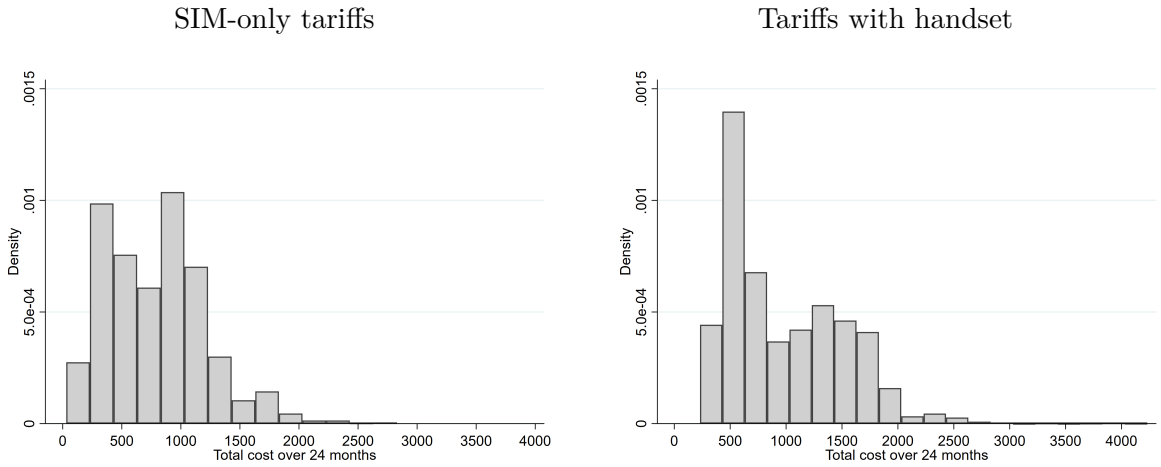
Notes: The table reports observable characteristics of subscribers and their selected alternative, by quarter of subscription. The bottom two rows report averages over the full sample period for two segments of consumers: those who selected a SIM-only tariff and those who selected a tariff bundled with a handset subsidy. Female, Smartphone, Apple, and Samsung are dummy variables. Age is measured in years, calls are measured in monthly minutes, and data usage is measured in GB per month. The table shows that observable consumer characteristics are relatively stable across subscription cohorts, while voice and data usage, as well as smartphone adoption, increase over the sample period. This supports the interpretation that the main results are not driven by large shifts in observable consumer composition.

Table OA.4: Handset-brand shares among subscribers, by year

	2011	2012	2013	2014	Overall (%)	Overall (individuals)
Apple	25.12	21.16	28.24	29.32	25.3	2,720
BlackBerry	17.39	15.23	5.86	1.36	13.1	1,407
HTC	1.44	1	2.3	1.29	1.4	155.0
LG	3.22	2.28	3.84	3.5	3.2	338.0
Motorola	1.06	0.55	0.35	0.26	0.8	80.0
Nokia	16.56	18.51	16.04	11.26	16.1	1,732
Samsung	32.95	39.44	28.66	29.58	33.2	3,567
Others	2.26	1.82	14.71	23.43	6.9	739.0
Total	100	100	100	100	100	10,738

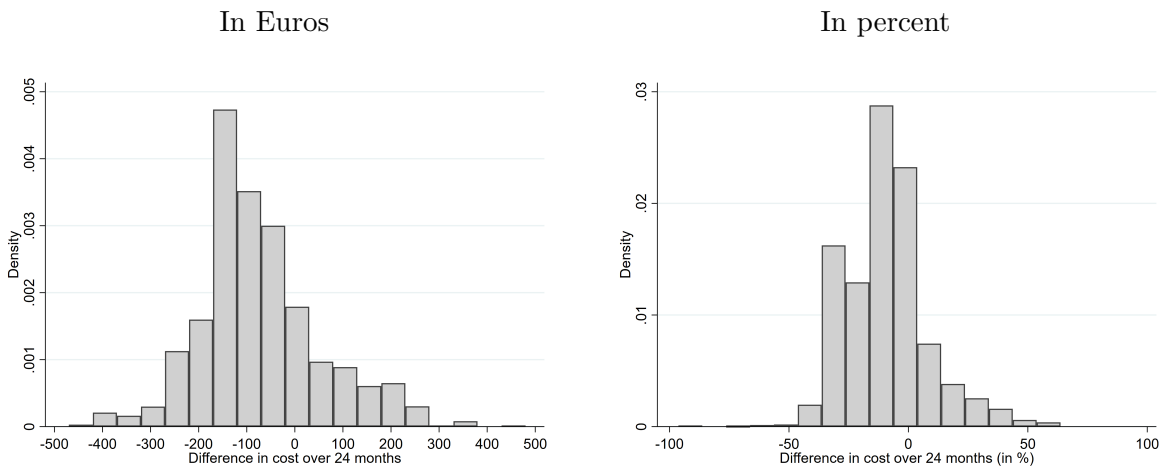
Notes: The table reports handset-brand shares among the 10,738 consumers in the final estimation sample. Columns 2011-2014 report yearly shares, in percent, among subscribers observed in each year. The last two columns report the overall brand share over the full sample period and the corresponding number of individuals.

Figure OA.2: Total cost over 24 months



Notes: The figure plots the present value of total selected handset-tariff costs over a common 24-month horizon. Computed for the 10,738 individuals in the estimation sample.

Figure OA.3: Difference in costs over 24 months



Notes: The figure compares the total costs of matched handset-tariff alternatives that differ only in whether the tariff is SIM-only or includes a handset subsidy. The comparison is computed for 4,680 individuals and is restricted to matched tariffs with comparable allowances and commitment length.

First stage price regressions

Table OA.5: Determinants of handset prices

Dependent variable: Handset list price (in euros) *Estimation method: OLS*	(1)	
Characteristics		
Brand dummies (35 brands)	0.00	(.)
Dummy smartphone=1	26.52	(30.13)
Dummy smartphone=1 × Android	-14.11	(32.23)
Dummy smartphone=1 × BlackBerry	0.00	(.)
Dummy smartphone=1 × No os	0.00	(.)
Dummy smartphone=1 × Other os	0.00	(.)
Dummy smartphone=1 × Windows	52.24	(49.58)
Dummy smartphone=1 × iOS	0.00	(.)
Camera quality (MP)=0	0.00	(.)
Camera quality (MP)=1300	-5.29	(17.80)
Camera quality (MP)=2000	-36.61*	(14.60)
Camera quality (MP)=3000	3.18	(19.51)
Camera quality (MP)=4000	271.61***	(78.84)
Camera quality (MP)=5000	32.31	(29.02)
Camera quality (MP)=6000	80.87	(42.60)
Camera quality (MP)=8000	80.09*	(38.35)
Camera quality (MP)=10000	155.57**	(50.36)
Camera quality (MP)=12000	170.54**	(53.72)
Camera quality (MP)=13000	133.99*	(56.64)
Camera quality (MP)=16000	132.55	(92.12)
Camera quality (MP)=20000	116.38	(81.71)
Camera quality (MP)=41000	3.62	(137.20)
LTE	77.03	(48.13)
Screen size	64.71***	(19.11)
Height	-2.17	(1.11)
Width	-3.70	(1.90)
Thickness	-9.51	(5.31)
Weight	2.70***	(0.73)
Cost shifters		
Dummy smartphone=1 × Time trend	-1.33	(1.33)
Brands × Time trend	-7.47	(5.24)
OS × Time trend	Yes	
Camera quality (MP) × Time trend	0.00**	(0.00)
LTE × Time trend	-0.90	(1.20)
Screen size × Time trend	-2.02***	(0.53)
Height × Time trend	0.06*	(0.03)
Width × Time trend	0.12*	(0.05)
Thickness × Time trend	0.17	(0.14)
Weight × Time trend	-0.04**	(0.02)
Constant	247.27	(194.58)
Observations	8801	
R^2	0.746	

Standard errors in parentheses, clustered at the handset level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This hedonic price regression uses the handset list price in euros for handsets in the sample. Acer is the omitted category for brand dummies. The regression explains handset list prices using observed handset characteristics and cost shifters based on interactions between key handset characteristics and time. The residuals from this regression enter the demand model as part of the control-function correction for endogeneity of the upfront handset cost (See, for example, Model IV in Table A.1).

Table OA.6: Determinants of tariff prices

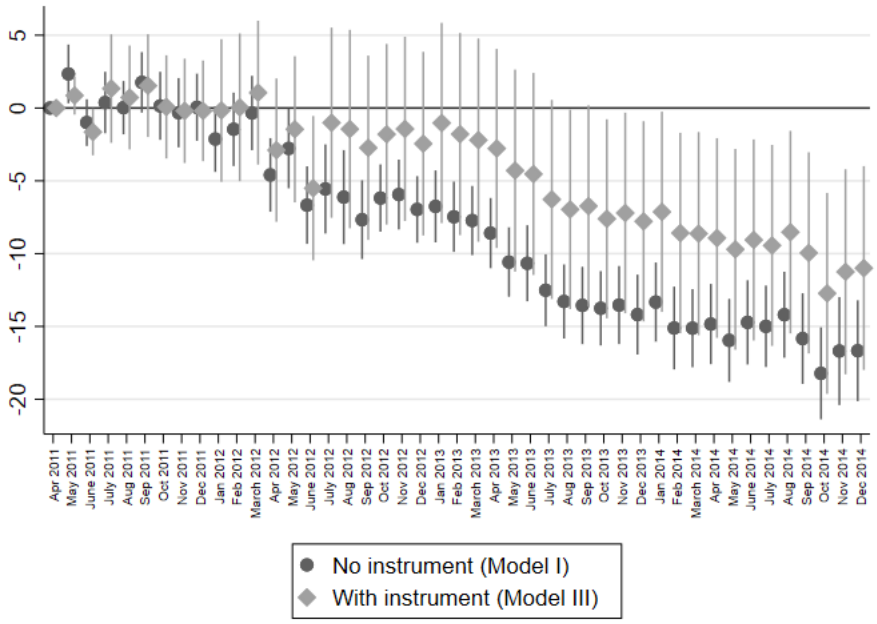
Dependent variable: Tariff list price (in euros)	(1) Tariff price		(2) Tariff price		(3) Tariff price	
Estimation method: OLS	No instrument		4G Antennas		Mobile Termination Rates	
Characteristics						
Commitment period=0	0.00	(.)	0.00	(.)	0.00	(.)
Commitment period=12	-6.62***	(1.52)	-6.59***	(1.52)	-6.41***	(1.53)
Commitment period=24	-9.70***	(1.66)	-9.67***	(1.66)	-9.61***	(1.65)
Tariff with handset=1	11.11***	(1.02)	11.12***	(1.02)	11.36***	(0.97)
Call allowance=30	0.00	(.)	0.00	(.)	0.00	(.)
Call allowance=60	3.57*	(1.47)	3.55*	(1.46)	5.09	(3.57)
Call allowance=90	4.44**	(1.63)	4.43**	(1.63)	10.12**	(3.55)
Call allowance=120	7.46***	(1.49)	7.44***	(1.49)	4.73	(3.60)
Call allowance=180	14.72***	(2.04)	14.74***	(2.04)	11.24*	(4.70)
Call allowance=240	19.15***	(2.65)	19.16***	(2.65)	22.38***	(4.34)
Call allowance=300	26.16***	(2.85)	26.18***	(2.85)	23.58***	(4.60)
Call allowance=1000	22.03***	(2.13)	22.06***	(2.13)	-6.43	(4.33)
Data allowance=0	0.00	(.)	0.00	(.)	0.00	(.)
Data allowance=500	7.94***	(0.88)	7.93***	(0.88)	6.75***	(0.84)
Data allowance=1000	13.58***	(1.48)	13.44***	(1.58)	12.31***	(1.29)
Data allowance=2000	25.51***	(1.89)	25.41***	(1.98)	23.19***	(1.76)
Data allowance=4000	38.27***	(3.26)	38.08***	(3.89)	34.07***	(2.75)
Data allowance=6000	63.68***	(6.34)	62.77***	(7.68)	60.63***	(6.20)
Data allowance=10000	65.04***	(5.22)	64.82***	(9.44)	62.09***	(5.06)
Fixed broadband-DSL	21.45***	(1.19)	21.45***	(1.19)	21.93***	(1.07)
Fixed broadband-FTTH	21.40***	(1.45)	21.50***	(1.44)	21.62***	(1.36)
Fixed bill option=1	9.82***	(0.89)	9.83***	(0.89)	9.83***	(1.00)
Web-only mobile plan=1	-19.93***	(3.85)	-20.07***	(3.80)	-19.77***	(2.94)
4G tariff	-18.29***	(2.50)	-15.89***	(3.77)	-11.38***	(1.96)
Cost shifters						
Data allowance × Number of 4G active antennas			0.02	(0.23)		
4G Tariff × Number of 4G active antennas			-0.48	(0.65)		
Call allowance=60 × Mobile termination rate					-1.68	(1.66)
Call allowance=90 × Mobile termination rate					-2.32	(1.59)
Call allowance=120 × Mobile termination rate					2.08	(1.68)
Call allowance=180 × Mobile termination rate					2.97	(2.25)
Call allowance=240 × Mobile termination rate					-0.71	(2.25)
Call allowance=300 × Mobile termination rate					3.00	(2.73)
Unlimited calls=1 × Mobile termination rate					26.52***	(3.47)
Month dummies	Yes		Yes		Yes	
Constant	15.89***	(2.04)	15.89***	(2.04)	12.75***	(2.40)
Observations	12906		12906		12906	
R^2	0.700		0.700		0.733	

Standard errors in parentheses, clustered at the tariff-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: These hedonic price regressions use the monthly tariff price, in euros, as the dependent variable. April 2011 is the omitted category for month dummies, which are reported in Figure OA.4. "Mobile Termination Rate" denotes the mobile termination rate, measured in euro cents per minute, charged by another operator for completing an outgoing call on its network; it therefore captures a per-minute wholesale cost faced by the calling operator. Antennas are measured in thousands. The regression explains monthly tariff prices using tariff characteristics, month dummies, and alternative cost shifters. The preferred control-function specification uses the residuals from Model III as controls for unobserved tariff-price components that may be correlated with utility (See, for example, Model IV of Table A.1).

Figure OA.4: Month coefficients from hedonic tariff-price regressions



Notes: The figure reports the estimated month coefficients from the hedonic tariff-price regressions presented in Table OA.6. April 2011 is the omitted base period. The coefficients measure changes in monthly tariff prices relative to April 2011, conditional on the tariff characteristics (and cost shifters in Model III) included in the first stage regressions.

Table OA.7: Hedonic tariff-price regression in the pre-SIM-only period

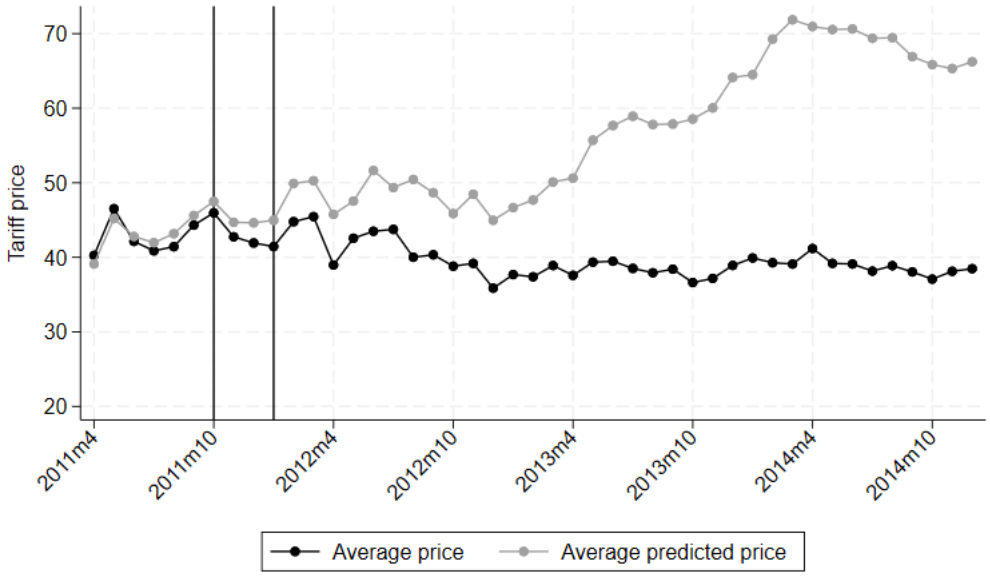
Dependent variable: Tariff list price (in euros) *Estimation method: OLS*	(1)	
Commitment period=0	0.00	(.)
Commitment period=12	-1.11	(3.45)
Commitment period=24	-5.34	(3.49)
Tariff with handset=1	9.55***	(1.58)
Call allowance=30	0.00	(.)
Call allowance=60	0.70	(1.55)
Call allowance=90	4.07*	(1.69)
Call allowance=120	8.30***	(1.56)
Call allowance=180	18.53***	(2.22)
Call allowance=240	23.20***	(2.96)
Call allowance=300	34.41***	(3.91)
Call allowance=Unlimited	41.48***	(5.94)
Call allowance=Unlimited+	109.69***	(6.40)
Data allowance=0	0.00	(.)
Data allowance=500	7.06***	(1.21)
Data allowance=1000	14.56***	(2.62)
Data allowance=2000	21.54***	(2.32)
Data allowance=4000	18.24***	(4.23)
Fixed broadband-DSL=1	29.72***	(1.97)
Fixed broadband-FTTH=1	18.22*	(7.75)
Fixed bill option=1	9.29***	(1.34)
Web-only mobile plan=1	0.00	(.)
4G tariff	0.00	(.)
Constant	10.14**	(3.31)
Observations	1,523	
R^2	0.880	

Standard errors, clustered at the tariff-level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table reports a hedonic tariff-price regression estimated on the pre-SIM-only period, from Q2 2011 to Q3 2011. The dependent variable is the monthly tariff list price, in euros. The specification corresponds to Model I in Table OA.6, restricted to the pre-period. Compared with the main model, however, the unlimited-calls category is split into "Unlimited" and "Unlimited+", since the latter option, which included calls to selected international destinations, was prevalent during this period. The estimated coefficients are used to predict counterfactual prices for later tariffs under the pre-October 2011 pricing schedule.

Figure OA.5: Observed and predicted tariff prices under the pre-October 2011 price structure



Notes: The figure compares observed tariff prices with prices predicted with the hedonic tariff-price regression estimated on the pre-SIM-only period, from April 2011 to September 2011 (See Table OA.7). The fit is expected to be very good during the calibration period, i.e., before the first vertical line. After October 2011, predicted prices lie above observed prices, consistent with the decline in tariff prices following the launch of low-cost SIM-only brands and the entry of the new operator. These predicted prices are used in the counterfactual scenarios that "remove" the post-October 2011 price decline.

OA.3 Measurement error in tariff bills and overage charges

The baseline specification uses the tariff list price as the monthly recurring charge. This price corresponds to the advertised catalog price observed by consumers when choosing among plans. Realized bills may differ from this amount because consumers may incur roaming charges, charges for calls to non-included numbers, or voice and data usage outside the allowance. The main text discusses the direction of the possible bias. This section provides additional evidence on the likely magnitude of this measurement issue and clarifies why it is unlikely to drive the main results.

The measurement concern is relevant for the attention-weight estimates only under specific conditions. First, consumers must anticipate the additional charges at the time of subscription. Second, expected overages must vary systematically across tariff alternatives in a way that is

not captured by observed tariff characteristics, such as call allowances, data allowances, commitment length, tariff type, usage variables, and time effects. Charges that are common across all alternatives for a given consumer do not affect utility differences across alternatives and therefore do not affect conditional logit choice probabilities. This is the case, for example, for charges generated by travel, calls to destinations not covered by any plan, or other usage shocks that are unrelated to the selected tariff. Such charges may affect realized bills, but they are not informative about the relative attractiveness of the handset-tariff alternatives in the choice set.

The relevant concern is instead that expected overages may be higher for cheaper or less generous tariffs. In that case, using the tariff list price alone would understate the expected cost of these alternatives and attenuate the coefficient on future recurring costs. Since the attention weight is computed as $\gamma = \alpha_2/\alpha_1$, and both price coefficients are negative, such attenuation would bias γ downward and would therefore lead me to overstate the degree of under-attention to future recurring payments.

Several features of the setting suggest that this concern is limited, although it cannot be ruled out entirely. First, the relevant object for the subscription decision is the expected bill at the time of choice, not the bill realized ex post. Many overages are plausibly difficult to anticipate when the consumer subscribes: they may be caused by temporary usage shocks, travel, calls to non-included numbers, automatic data use, or changes in usage needs. These charges may affect realized bills without necessarily entering the ex-ante comparison of handset-tariff combinations. Second, out-of-bundle charges are typically structured as additive unit charges rather than proportional markups on the tariff list price. They are therefore better viewed as additive bill components, or as allowance-related shocks, than as proportional increases in tariff prices. Third, I do not observe realized overage charges in the operator data and therefore cannot compute the incidence or magnitude of overages directly in my setting. However, the descriptive statistics reported in Table 1 indicate that large systematic overages are unlikely for the average consumer. Average data consumption is 0.23 GB per month, while the average data allowance is 0.87 GB. For voice, 26% of selected tariffs include unlimited calls; among tariffs with limited calls, the average allowance is 79 minutes, close to the average observed usage of 84 minutes.

These averages do not rule out overages for high-usage consumers or for consumers making calls outside the allowance, but they suggest that consumers are not, on average, choosing tariffs with allowances far below their realized consumption.

Modeling expected overages directly would require strong additional assumptions. One would need to specify consumers' expected future usage at the time of subscription, the distribution of usage shocks over the contract horizon, the relevant out-of-bundle prices for calls, SMS, data, and roaming, and the extent to which consumers anticipate these charges when choosing a plan. Moreover, an allowance-based correction would require deciding, for each alternative in each consumer's choice set, whether the consumer would have exceeded the corresponding allowance under that counterfactual tariff. This is not directly observed and would require assumptions about how usage would adjust to different allowances and prices. I therefore do not construct alternative-specific expected bills. Instead, I interpret the tariff list price as the recurring charge that is observable and comparable at the time of subscription, and I discuss the likely direction and magnitude of the remaining measurement issue.

Also, contemporaneous regulatory evidence supports the view that bill shocks exist and can be substantial when they occur, but that they affect a minority of mobile contract customers in a given period. Ofcom (2012) reports that, in a November 2010 omnibus survey of approximately 2,000 adults, 6% of mobile consumers had received an unexpectedly high mobile bill in the previous 12 months. Conditional on bill shock occurring, the amounts could be substantial: among affected mobile consumers, the median unexpected amount was between 31 and 50 pounds. Mobile use abroad generated particularly large additional charges conditional on occurrence, making roaming-related charges an important source of severe bill shocks.[65] These figures indicate that overages can be important for affected consumers, but that their unconditional monthly amount is likely to be limited for the typical contract customer.

Evidence from the United States also suggests that bill shock was a relevant consumer issue

[65] More detailed Ofcom evidence for 2012 reports low annual incidence rates for specific sources of bill shock among mobile contract customers: 3% for calls to numbers outside the allowance, 2% for exceeding the monthly voice allowance, 1% for using data not included in the allowance, and 0.5% for exceeding the data allowance. Conditional on occurrence, the average additional amounts were about 19 pounds for calls outside the allowance, 43 pounds for exceeding the voice allowance, 15 pounds for pay-as-you-go data, and 30 pounds for exceeding the data allowance. Additional charges related to mobile use abroad were larger, around 60 pounds on average.

during this period. Horrigan and Satterwhite (2010) report that 17% of U.S. adults with a cell phone had experienced bill shock. Among affected consumers, the most recent unexpected increase was 1 to 24 dollars for 36% of consumers, while 23% reported an unexpected increase above 100 dollars. Related evidence from Grubb and Osborne (2015), based on U.S. university students in an earlier, voice-centered mobile market, is less directly comparable to my setting but useful for interpreting the mechanism: they show that consumers are uncertain about ex-post marginal prices, inattentive to remaining allowances, and exposed to bill shock. This supports the view that many overages are realized ex post and may not be fully incorporated into the subscription decision. More broadly, Grubb (2009) shows how consumer overconfidence about future usage can sustain three-part tariffs with included allowances and high overage charges.

Moreover, the largest roaming-related bill shocks were already partly constrained before the start of the sample period. From March 2010 onward, EU transparency rules required operators to allow consumers to set a maximum spending limit for data roaming abroad. From July 2010, a default cut-off limit of 50 euros applied to consumers who had not chosen another limit (European Commission, 2010). This does not eliminate all roaming-related charges, but it reduces the likelihood of extreme EU data-roaming shocks.

Overall, the external evidence suggests that overages and bill shocks are real and can be substantial for affected consumers, but that they are unlikely to generate large systematic measurement error for the average subscriber. In the data used in this paper, average allowances are generally larger than average realized consumption, especially for data. Charges that are common across alternatives do not affect relative utilities. Charges that vary with allowances could, in principle, bias the coefficient on future costs downward, but constructing a credible alternative-specific expected-bill measure would require assumptions that are not supported by the data. I therefore keep the tariff list price as the measure of the recurring charge observed at subscription. The remaining measurement concern should be interpreted as a possible source of downward bias in γ, meaning that the estimates may, if anything, understate the attention consumers pay to future recurring payments.

Additional analyses

Table OA.8: Regression with share of SIM-only

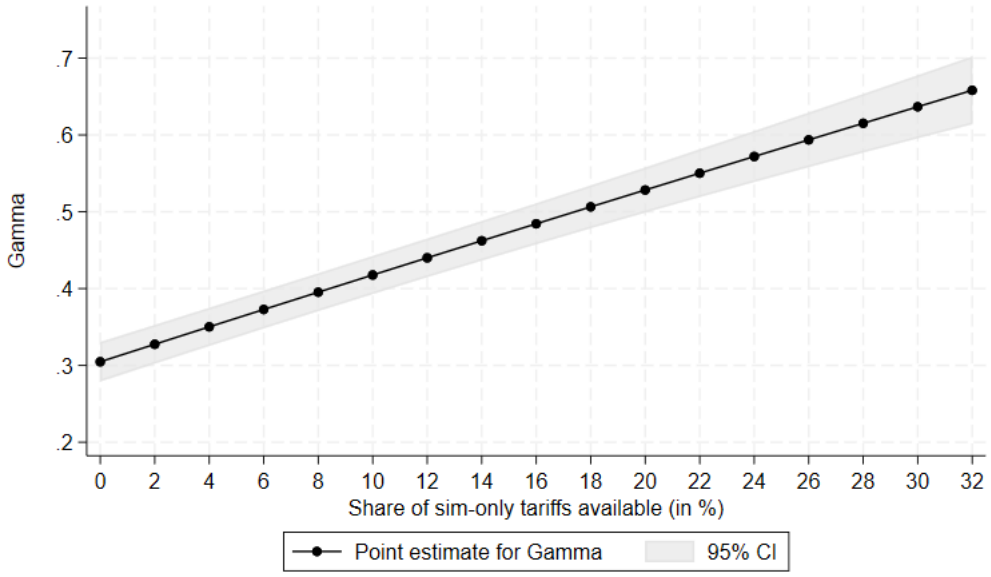
Dependent variable: Alternative is chosen (0/1) *Estimation method: Conditional logit*	(1) Main Model		(2) With SIM-only share interactions	
Upfront cost of the handset	-0.009***	(0.000)	-0.008***	(0.000)
Present value of future costs	-0.003***	(0.000)	-0.002***	(0.000)
Data: 500 MB=1	1.142***	(0.030)	1.145***	(0.030)
Data: 1GB = 1	1.727***	(0.049)	1.727***	(0.049)
Data: 2GB=1	2.012***	(0.055)	2.003***	(0.054)
Data: 4GB=1	1.878***	(0.067)	1.870***	(0.066)
Data: 10 GB=1	3.046***	(0.127)	3.231***	(0.119)
Unlimited calls=1	1.226***	(0.060)	1.178***	(0.059)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	0.002***	(0.000)
Fixed broadband=1	1.813***	(0.050)	1.769***	(0.049)
SIM-only, no commitment	-0.718***	(0.045)	-0.681***	(0.044)
SIM-only, 12 months contract	-2.907***	(0.062)	-2.886***	(0.061)
SIM-only, 24 months contract	-1.739***	(0.073)	-1.715***	(0.072)
Tariff with handset, 12 months contract	-4.345***	(0.055)	-4.311***	(0.054)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)
Dummy Apple	6.864***	(0.075)	6.772***	(0.074)
Dummy BlackBerry	2.897***	(0.060)	2.850***	(0.060)
Dummy HTC	0.038	(0.094)	0.018	(0.094)
Dummy LG	-0.110	(0.070)	-0.126	(0.070)
Dummy Motorola	-0.053	(0.126)	-0.078	(0.126)
Dummy Nokia	1.013***	(0.051)	1.007***	(0.051)
Dummy Samsung	1.643***	(0.047)	1.617***	(0.047)
Dummy smartphone=1	1.241***	(0.037)	1.261***	(0.037)
Handset age (months)	-0.007***	(0.001)	-0.006***	(0.001)
Height	0.019***	(0.002)	0.018***	(0.002)
Width	-0.006*	(0.003)	-0.005	(0.003)
Thickness	0.059***	(0.007)	0.056***	(0.007)
Camera quality (MP)	0.102***	(0.006)	0.096***	(0.006)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)
LTE × 4G tariff	1.259***	(0.070)	1.261***	(0.068)
Residuals from handset price regression	0.006***	(0.000)	0.005***	(0.000)
Residuals from tariff price regression	0.006***	(0.001)	0.006***	(0.001)
Interactions of prices with time	Yes		No	
Interactions of prices with age groups and gender	Yes		Yes	
Present value of future costs × Share SIM-only			-0.010***	(0.000)
Upfront × Share SIM-only			-0.001	(0.001)
Observations	3,851,776		3,851,776	
Log Likelihood	-4.42e+04		-4.45e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table reports specifications in which the coefficients on upfront handset costs and the present value of future recurring costs are interacted with the catalog share of SIM-only tariffs instead of subscription-quarter dummies. Both specifications retain interactions with age group and gender. Column 1 reports the main specification, corresponding to Model IV in Table A.1. Figure A.2 shows the evolution of the share of SIM-only tariffs used in this regression. This additional specification assesses whether changes in the tariff environment, rather than calendar-time variation alone, help explain the increase in the estimated attention weight γ.

Figure OA.6: Attention weight γ and the catalog share of SIM-only tariffs



Notes: The figure reports the values of γ implied by the specification in which the price coefficients vary with the catalog share of SIM-only tariffs, rather than with subscription-quarter dummies, as reported in Column 2 of Table OA.8. The figure provides a more direct descriptive link between the availability of SIM-only tariffs in the choice set and the estimated attention paid to future recurring costs.

Table OA.9: Determinants of consumers' choices with additional heterogeneity

Dependent variable: Alternative is chosen (0/1)	(1)		(2)	
Estimation method: Conditional logit	Model V		Model VI	
Upfront cost of handset	-0.013***	(0.00)	-0.013***	(0.00)
Present value of future costs	-0.004***	(0.00)	-0.004***	(0.00)
500 MB=1	1.145***	(0.03)	1.156***	(0.03)
1 GB=1	1.728***	(0.05)	1.749***	(0.05)
2 GB=1	2.016***	(0.05)	2.072***	(0.05)
4 GB=1	1.882***	(0.07)	1.939***	(0.07)
10 GB=1	3.057***	(0.13)	3.199***	(0.13)
Unlimited calls=1	1.231***	(0.06)	1.300***	(0.06)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.00)	0.002***	(0.00)
Fixed broadband=1	1.815***	(0.05)	1.884***	(0.05)
SIM-only no commitment	-0.721***	(0.04)	-0.762***	(0.04)
SIM-only 12 months contract	-2.911***	(0.06)	-2.982***	(0.06)
SIM-only, 24 months contract	-1.741***	(0.07)	-1.763***	(0.07)
Tariff with handset, 12 months contract	-4.347***	(0.05)	-4.388***	(0.05)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)
Dummy Apple	6.847***	(0.08)	6.825***	(0.08)
Dummy BlackBerry	2.897***	(0.06)	2.902***	(0.06)
Dummy HTC	0.039	(0.09)	0.049	(0.09)
Dummy LG	-0.113	(0.07)	-0.106	(0.07)
Dummy Motorola	-0.050	(0.13)	-0.044	(0.13)
Dummy Nokia	1.014***	(0.05)	1.019***	(0.05)
Dummy Samsung	1.646***	(0.05)	1.652***	(0.05)
Dummy smartphone=1	1.251***	(0.04)	1.254***	(0.04)
Handset age (months)	-0.007***	(0.00)	-0.007***	(0.00)
Height	0.019***	(0.00)	0.020***	(0.00)
Width	-0.006	(0.00)	-0.005	(0.00)
Thickness	0.059***	(0.01)	0.060***	(0.01)
Camera quality (MP)	0.102***	(0.01)	0.103***	(0.01)
Battery standby time (hours)	0.002***	(0.00)	0.002***	(0.00)
LTE × 4G tariff	1.254***	(0.07)	1.280***	(0.07)
Residuals from handset price regression	0.005***	(0.00)	0.005***	(0.00)
Residuals from tariff price regression	0.006***	(0.00)	0.007***	(0.00)
Interactions of prices with time	Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes	
Present value of future costs × City population density	-0.000	(0.00)	-0.000	(0.00)
Upfront cost of handset × City population density	0.000*	(0.00)	0.000*	(0.00)
Present value of future costs × City-level average income	0.000***	(0.00)	0.000***	(0.00)
Upfront cost of handset × City-level average income	0.002***	(0.00)	0.002***	(0.00)
Present value of future costs × City-level unemployment rate	0.004***	(0.00)	0.003**	(0.00)
Upfront cost of handset × City-level unemployment rate	0.014***	(0.00)	0.013***	(0.00)
Present value of future costs × Calls (usage in minutes)			0.012***	(0.00)
Upfront cost of handset × Calls (usage in minutes)			0.005	(0.00)
Present value of future costs × Data usage			0.049***	(0.00)
Upfront cost of handset × Data usage			0.085***	(0.01)
Observations	3,849,488		3,849,488	
Log Likelihood	-4.41e+04		-4.39e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table reports specifications that extend Model IV in Table A.1 by allowing the coefficients on upfront handset costs and the present value of future recurring costs to vary with additional socio-demographic and usage variables. In all specifications, these price coefficients are also interacted with subscription quarter, age group, and gender. Continuous interaction variables are rescaled for readability: city-level population density is expressed in tens of thousands of inhabitants per km^2 (mean = 0.20; sd = 0.43), city-level average income in tens of thousands of euros (mean = 1.40; sd = 0.40), unemployment as a rate (mean = 0.08; sd = 0.03), calls in tens of thousands of minutes (mean = 0.008; sd = 0.025), and data usage in hundreds of GB (mean = 0.002; sd = 0.008).

Robustness checks

Alternative r

Table OA.10: Determinants of consumers' choices with alternative market interest rates

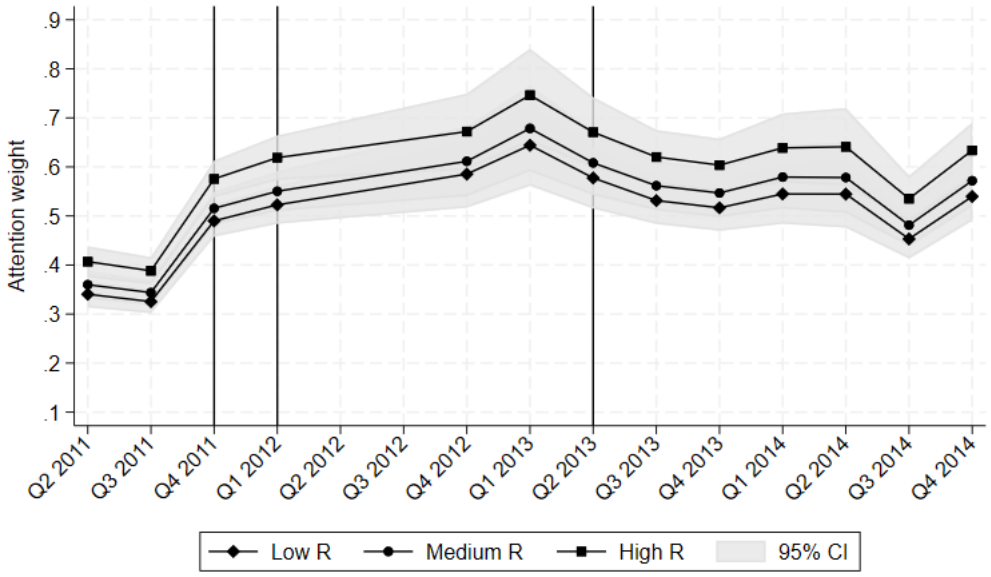
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)	
Estimation method: Conditional logit	Medium r		Low r		High r	
Upfront cost of handset	-0.009***	(0.000)	-0.009***	(0.000)	-0.009***	(0.000)
Present value of future costs	-0.003***	(0.000)				
Present value of future costs (low r)			-0.003***	(0.000)		
Present value of future costs (high r)					-0.004***	(0.000)
500 MB=1	1.142***	(0.030)	1.137***	(0.030)	1.154***	(0.030)
1 GB=1	1.727***	(0.049)	1.719***	(0.049)	1.743***	(0.049)
2 GB=1	2.012***	(0.055)	1.989***	(0.054)	2.056***	(0.055)
4 GB=1	1.878***	(0.067)	1.842***	(0.067)	1.944***	(0.067)
10 GB=1	3.046***	(0.127)	2.969***	(0.126)	3.182***	(0.128)
Unlimited calls=1	1.226***	(0.060)	1.190***	(0.060)	1.294***	(0.061)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)
Fixed broadband=1	1.813***	(0.050)	1.778***	(0.049)	1.877***	(0.050)
SIM-only no commitment	-0.718***	(0.045)	-0.719***	(0.045)	-0.712***	(0.045)
SIM-only 12 months contract	-2.907***	(0.062)	-2.912***	(0.062)	-2.890***	(0.062)
SIM-only, 24 months contract	-1.739***	(0.073)	-1.732***	(0.073)	-1.753***	(0.073)
Tariff with handset, 12 months contract	-4.345***	(0.055)	-4.370***	(0.055)	-4.283***	(0.054)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	6.864***	(0.075)	6.860***	(0.075)	6.872***	(0.075)
Dummy BlackBerry	2.897***	(0.060)	2.895***	(0.060)	2.899***	(0.060)
Dummy HTC	0.038	(0.094)	0.037	(0.094)	0.039	(0.094)
Dummy LG	-0.110	(0.070)	-0.111	(0.070)	-0.110	(0.070)
Dummy Motorola	-0.053	(0.126)	-0.054	(0.126)	-0.051	(0.126)
Dummy Nokia	1.013***	(0.051)	1.013***	(0.051)	1.014***	(0.051)
Dummy Samsung	1.643***	(0.047)	1.642***	(0.047)	1.645***	(0.047)
Dummy smartphone=1	1.241***	(0.037)	1.241***	(0.037)	1.241***	(0.037)
Handset age (months)	-0.007***	(0.001)	-0.007***	(0.001)	-0.007***	(0.001)
Height	0.019***	(0.002)	0.019***	(0.002)	0.019***	(0.002)
Width	-0.006*	(0.003)	-0.006*	(0.003)	-0.006*	(0.003)
Thickness	0.059***	(0.007)	0.059***	(0.007)	0.059***	(0.007)
Camera quality (MP)	0.102***	(0.006)	0.102***	(0.006)	0.103***	(0.006)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)
LTE × 4G tariff	1.259***	(0.070)	1.261***	(0.070)	1.252***	(0.070)
Residuals from handset price regression	0.006***	(0.000)	0.005***	(0.000)	0.006***	(0.000)
Residuals from tariff price regression	0.006***	(0.001)	0.005***	(0.001)	0.007***	(0.001)
Interactions of prices with time, age groups and gender	Yes		Yes		Yes	
Observations	3,851,776		3,851,776		3,851,776	
Log likelihood	-4.42e+04		-4.43e+04		-4.42e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table re-estimates the preferred specification after recomputing the present value of future recurring costs under low and high market interest-rate assumptions. The medium rate corresponds to the baseline specification and uses the average consumption-credit rate granted by banks, approximately 6% per year over the sample period. The low rate uses the state-regulated rate on short-term bank deposits, which varies between 1% and 2.25%. The high rate uses the consumption-credit rate charged by specialized lenders offering revolving credit, which ranges between 12.8% and 15.2%. In all columns, the price coefficients, on upfront handset costs and the present value of future recurring costs, are interacted with subscription quarter, age group, and gender. Column 1 (Medium r) corresponds to the preferred specification, Model IV in Table A.1.

Figure OA.7: Attention weight γ obtained with alternative market interest rate



Notes: The figure presents the evolution of γ based on the estimates reported in Table OA.10.

Alternative S

Table OA.11: Determinants of consumers' choices with alternative time horizons S

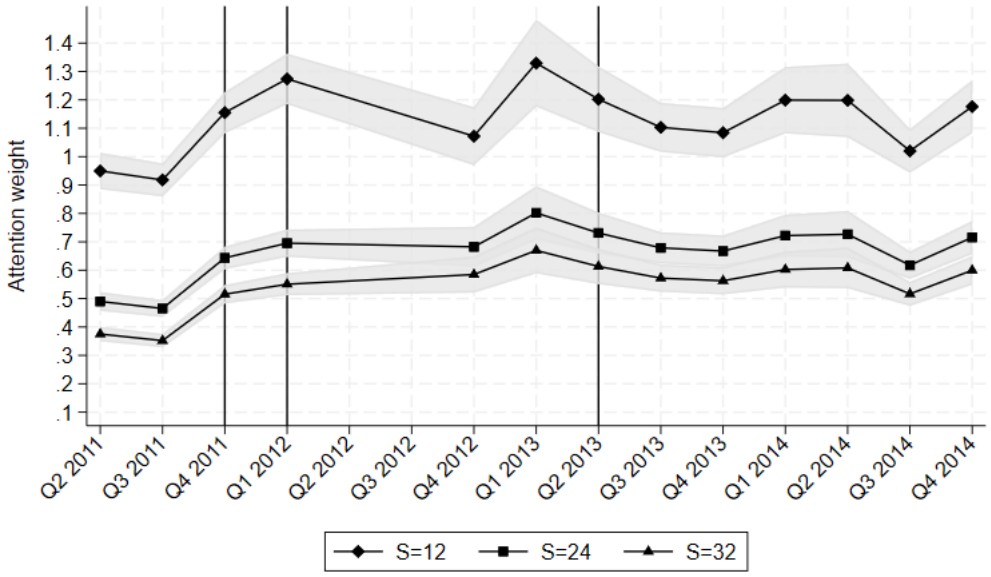
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)		(4)	
Dependent variable: Conditional logit	Main model		S=12		S=24		S=32	
Upfront cost of handset	-0.009***	(0.000)	-0.009***	(0.000)	-0.009***	(0.000)	-0.009***	(0.000)
Present value of future costs	-0.003***	(0.000)	-0.009***	(0.000)	-0.004***	(0.000)	-0.003***	(0.000)
Data: 500 MB=1	1.142***	(0.030)	1.301***	(0.030)	1.302***	(0.030)	1.302***	(0.030)
Data: 1 GB=1	1.727***	(0.049)	2.001***	(0.050)	2.002***	(0.050)	2.002***	(0.050)
Data: 2 GB=1	2.012***	(0.055)	2.599***	(0.058)	2.600***	(0.058)	2.601***	(0.058)
Data: 4 GB=1	1.878***	(0.067)	2.748***	(0.072)	2.751***	(0.072)	2.753***	(0.072)
Data: 10 GB=1	3.046***	(0.127)	4.882***	(0.143)	4.890***	(0.143)	4.895***	(0.143)
Unlimited calls=1	1.226***	(0.060)	2.116***	(0.067)	2.119***	(0.067)	2.121***	(0.067)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	0.005***	(0.000)	0.005***	(0.000)	0.005***	(0.000)
Fixed broadband=1	1.813***	(0.050)	2.730***	(0.060)	2.733***	(0.060)	2.735***	(0.060)
SIM-only no commitment	-0.718***	(0.045)	-0.523***	(0.046)	-0.523***	(0.046)	-0.523***	(0.046)
SIM-only 12 months contract	-2.907***	(0.062)	-1.866***	(0.058)	-1.864***	(0.058)	-1.863***	(0.058)
SIM-only, 24 months contract	-1.739***	(0.073)	-1.885***	(0.073)	-1.885***	(0.073)	-1.885***	(0.073)
Tariff with handset, 12 months contract	-4.345***	(0.055)	-2.436***	(0.052)	-2.434***	(0.052)	-2.432***	(0.052)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	6.864***	(0.075)	6.945***	(0.076)	6.946***	(0.076)	6.946***	(0.076)
Dummy BlackBerry	2.897***	(0.060)	2.918***	(0.060)	2.918***	(0.060)	2.918***	(0.060)
Dummy HTC	0.038	(0.094)	0.048	(0.094)	0.048	(0.094)	0.048	(0.094)
Dummy LG	-0.110	(0.070)	-0.112	(0.070)	-0.112	(0.070)	-0.112	(0.070)
Dummy Motorola	-0.053	(0.126)	-0.040	(0.126)	-0.040	(0.126)	-0.040	(0.126)
Dummy Nokia	1.013***	(0.051)	1.017***	(0.051)	1.017***	(0.051)	1.017***	(0.051)
Dummy Samsung	1.643***	(0.047)	1.654***	(0.047)	1.654***	(0.047)	1.654***	(0.047)
Dummy smartphone=1	1.241***	(0.037)	1.243***	(0.037)	1.243***	(0.037)	1.243***	(0.037)
Handset age (months)	-0.007***	(0.001)	-0.008***	(0.001)	-0.008***	(0.001)	-0.008***	(0.001)
Height	0.019***	(0.002)	0.020***	(0.002)	0.020***	(0.002)	0.020***	(0.002)
Width	-0.006*	(0.003)	-0.006	(0.003)	-0.006	(0.003)	-0.006	(0.003)
Thickness	0.059***	(0.007)	0.060***	(0.007)	0.060***	(0.007)	0.060***	(0.007)
Camera quality (MP)	0.102***	(0.006)	0.106***	(0.006)	0.106***	(0.006)	0.106***	(0.006)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)
LTE × 4G tariff	1.259***	(0.070)	1.153***	(0.070)	1.153***	(0.070)	1.154***	(0.070)
Residuals from handset price regression	0.006***	(0.000)	0.006***	(0.000)	0.006***	(0.000)	0.006***	(0.000)
Residuals from tariff price regression	0.006***	(0.001)	0.025***	(0.002)	0.025***	(0.002)	0.025***	(0.002)
Interactions of prices with time	Yes		Yes		Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes		Yes		Yes	
Observations	3,851,776		3,851,776		3,851,776		3,851,776	
Log likelihood	-4.42e+04		-4.36e+04		-4.36e+04		-4.36e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table re-estimates the model after recomputing future tariff costs using alternative common horizons of 12, 24, and 32 months, instead of the baseline horizon that varies with contract commitment status. Column 1 reports the preferred specification, Model IV in Table A.1.

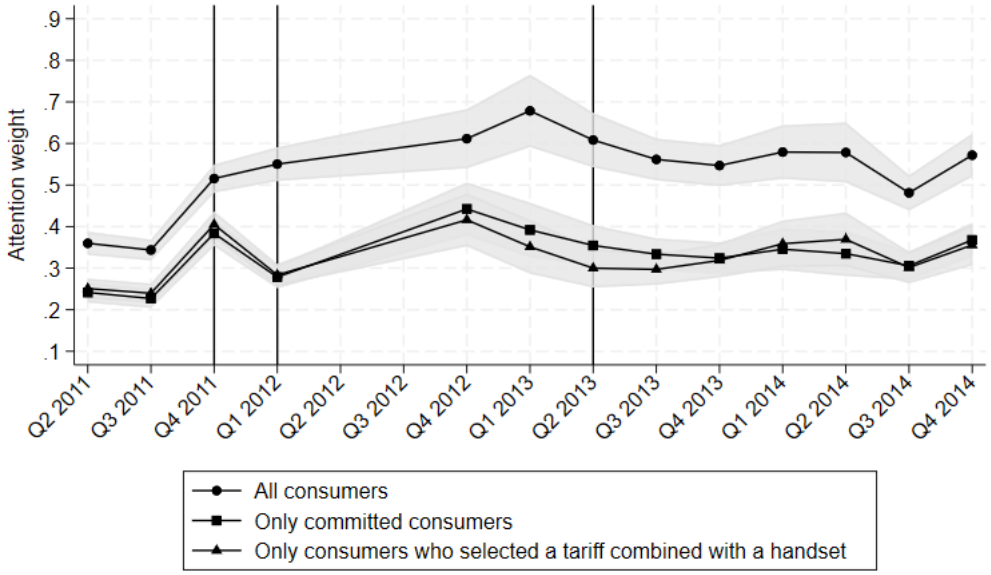
Figure OA.8: Attention weight γ obtained with alternative time horizons S



Notes: The figure presents the evolution of γ based on the estimates reported in Table OA.11.

Alternative samples

Figure OA.9: Attention weight γ obtained with estimates from alternative models



Notes: The figure compares the baseline estimates, obtained for all consumers using Model IV in Table A.1, with estimates obtained on restricted samples. The restricted samples include committed subscribers, defined as consumers choosing contracts with a 12- or 24-month commitment period (including SIM-only contracts with commitment), and subscribers choosing tariffs bundled with a handset. This robustness check assesses whether the increase in γ is mechanically driven by the growing share of SIM-only subscribers in the sample. The full set of estimates is not reported.

Table OA.12: Determinants of consumers' choices by year

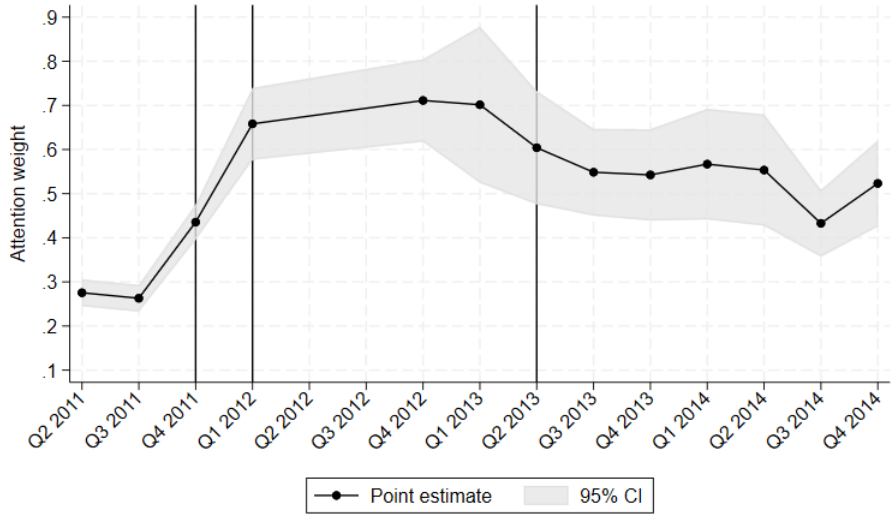
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)		(4)	
Estimation method: Conditional logit	Cohort 2011		Cohort 2012		Cohort 2013		Cohort 2014	
Upfront cost of handset	-0.010***	(0.000)	-0.008***	(0.001)	-0.007***	(0.001)	-0.007***	(0.001)
Present value of future costs	-0.003***	(0.000)	-0.007***	(0.001)	-0.004***	(0.000)	-0.004***	(0.000)
Data: 500 MB=1	1.441***	(0.040)	0.951***	(0.063)	0.269**	(0.084)	0.232*	(0.102)
Data: 1 GB=1	1.424***	(0.080)	2.284***	(0.092)	0.257	(0.158)	0.670***	(0.141)
Data: 2 GB=1	1.745***	(0.091)	2.148***	(0.129)	1.130***	(0.130)	1.179***	(0.156)
Data: 4 GB=1	1.814***	(0.122)	1.158***	(0.301)	0.582***	(0.167)	0.874***	(0.167)
Data: 10 GB=1	0.000	(.)	0.000	(.)	0.000	(.)	1.994***	(0.246)
Unlimited calls=1	0.148	(0.157)	1.130***	(0.151)	1.687***	(0.147)	1.391***	(0.165)
Unlimited calls=0 × Allowance (minutes)	-0.000	(0.000)	0.001	(0.001)	0.004***	(0.001)	0.006***	(0.001)
Fixed broadband=1	1.687***	(0.086)	3.027***	(0.134)	1.102***	(0.122)	0.874***	(0.120)
SIM-only no commitment	-2.243***	(0.157)	-0.235*	(0.094)	-0.463***	(0.101)	-0.655***	(0.106)
SIM-only 12 months contract	-4.082***	(0.216)	-3.532***	(0.176)	-2.138***	(0.128)	-2.364***	(0.129)
SIM-only, 24 months contract	-1.460***	(0.097)	-1.351***	(0.126)	-17.627	(571.094)	-17.083	(481.349)
Tariff with handset, 12 months contract	-3.799***	(0.077)	-4.675***	(0.139)	-4.050***	(0.151)	-5.081***	(0.206)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	8.046***	(0.134)	7.684***	(0.217)	5.390***	(0.185)	5.454***	(0.176)
Dummy BlackBerry	4.089***	(0.114)	3.970***	(0.188)	1.402***	(0.155)	-0.126	(0.242)
Dummy HTC	0.624***	(0.154)	0.758**	(0.277)	-0.161	(0.200)	-0.385	(0.239)
Dummy LG	0.394**	(0.124)	0.409	(0.221)	-0.181	(0.164)	0.131	(0.164)
Dummy Motorola	0.790***	(0.165)	0.528	(0.337)	-1.109*	(0.460)	-16.925	(2867.562)
Dummy Nokia	1.687***	(0.106)	1.959***	(0.176)	0.542***	(0.115)	0.480***	(0.109)
Dummy Samsung	2.081***	(0.099)	2.790***	(0.170)	0.967***	(0.099)	1.469***	(0.084)
Dummy smartphone=1	0.974***	(0.053)	1.298***	(0.082)	0.543***	(0.102)	1.004***	(0.140)
Handset age (months)	-0.031***	(0.003)	0.007*	(0.003)	0.007**	(0.003)	-0.002	(0.003)
Height	0.021***	(0.003)	0.043***	(0.004)	-0.002	(0.004)	0.011**	(0.004)
Width	0.022***	(0.005)	-0.021**	(0.007)	0.005	(0.008)	-0.038***	(0.008)
Thickness	0.068***	(0.011)	0.097***	(0.016)	-0.034	(0.021)	0.042*	(0.020)
Camera quality (MP)	0.157***	(0.014)	0.117***	(0.015)	0.059***	(0.016)	0.094***	(0.009)
Battery standby time (hours)	0.003***	(0.000)	0.003***	(0.000)	0.002***	(0.000)	0.001***	(0.000)
LTE × 4G tariff	-8.818	(801.184)	2.313***	(0.590)	1.906***	(0.136)	1.412***	(0.091)
Residuals from handset price regression	0.006***	(0.000)	0.007***	(0.000)	0.004***	(0.000)	0.005***	(0.000)
Residuals from tariff price regression	-0.012***	(0.003)	0.012**	(0.004)	0.017***	(0.004)	0.008	(0.004)
Interactions of prices with time	Yes		Yes		Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes		Yes		Yes	
Observations	1,909,875		840,579		548,220		553,102	
Log likelihood	-2.07e+04		-8561.812		-6558.893		-6887.685	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

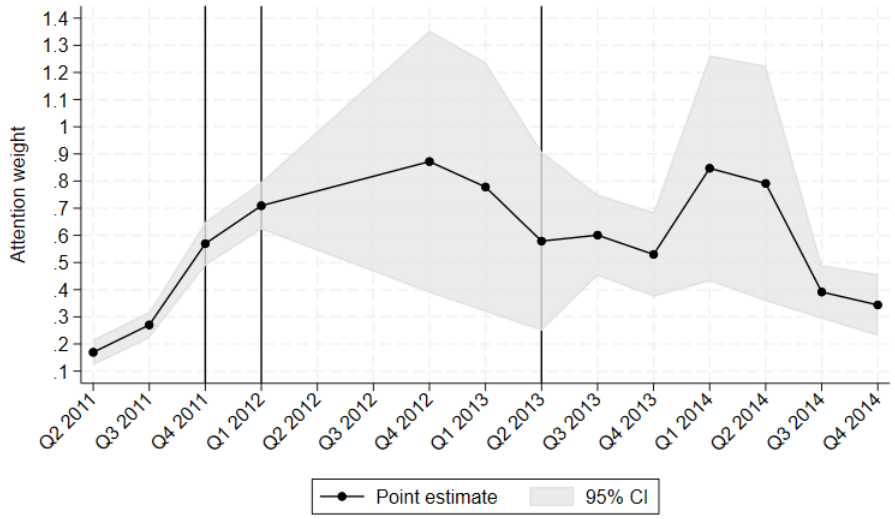
Notes: The table estimates the demand model separately by year, allowing the valuation of product characteristics to vary more flexibly over time. The coefficients on upfront handset costs and the present value of future recurring costs are interacted with subscription quarter, age group, and gender. Within each year, Q2 is the omitted quarter.

Figure OA.10: Attention weight γ from yearly regressions



Notes: The figure plots the γ estimates implied by the year-specific models presented in Table OA.12.

Figure OA.11: Attention weight γ from quarterly regressions



Notes: The figure plots estimates of γ from models estimated separately by quarter. Confidence intervals are wide because each quarter-level regression relies on a relatively small number of observations.

Alternative choice sets

Table OA.13: Determinants of consumers' choices with larger choice sets

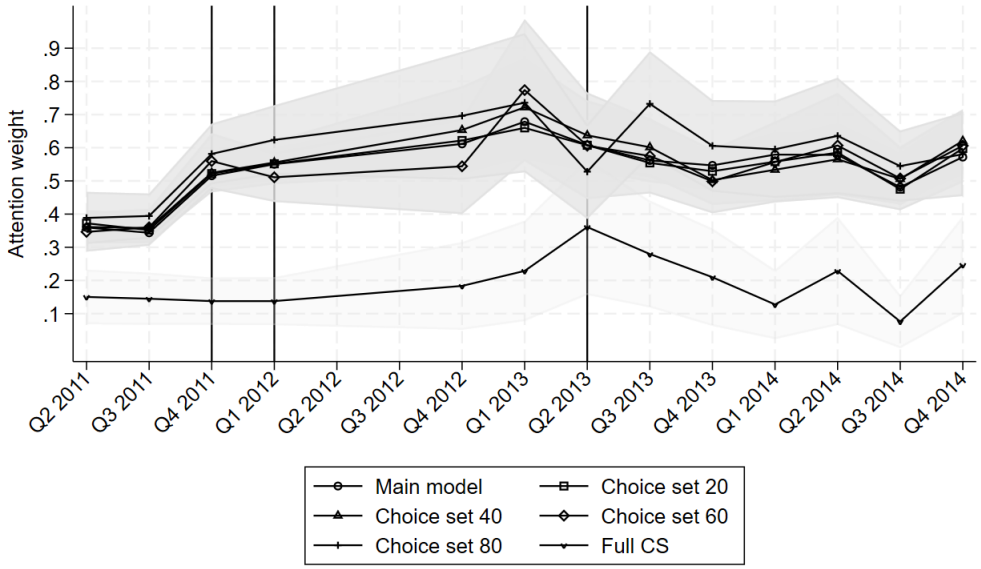
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)		(4)		(5)	
Estimation method: Conditional logit	CS: 20-20		CS: 40-40		CS: 60-60		CS: 80-80		Full CS	
Upfront cost of handset	-0.008***	(0.000)	-0.008***	(0.000)	-0.007***	(0.000)	-0.007***	(0.001)	-0.021***	(0.002)
Present value of future costs	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.001)
Data: 500 MB=1	1.213***	(0.035)	1.205***	(0.049)	1.322***	(0.060)	1.334***	(0.069)	1.221***	(0.203)
Data: 1 GB=1	1.748***	(0.056)	1.705***	(0.078)	1.692***	(0.098)	1.718***	(0.111)	1.374***	(0.374)
Data: 2 GB=1	1.992***	(0.063)	1.917***	(0.088)	1.917***	(0.109)	1.927***	(0.128)	1.926***	(0.402)
Data: 4 GB=1	1.821***	(0.077)	1.811***	(0.107)	1.804***	(0.132)	1.785***	(0.151)	1.085*	(0.540)
Data: 10 GB=1	3.259***	(0.146)	3.247***	(0.206)	2.962***	(0.257)	3.286***	(0.290)	2.850**	(0.936)
Unlimited calls=1	1.244***	(0.070)	1.293***	(0.097)	1.169***	(0.120)	1.371***	(0.139)	1.387***	(0.407)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	0.002***	(0.000)	0.001	(0.001)	0.002***	(0.001)	0.002	(0.002)
Fixed broadband=1	1.805***	(0.058)	1.868***	(0.079)	1.653***	(0.098)	1.873***	(0.115)	1.254**	(0.390)
SIM-only no commitment	-0.725***	(0.052)	-0.781***	(0.074)	-0.840***	(0.093)	-0.999***	(0.108)	-1.217***	(0.298)
SIM-only 12 months contract	-2.934***	(0.074)	-3.009***	(0.104)	-2.924***	(0.128)	-2.968***	(0.144)	-2.911***	(0.378)
SIM-only, 24 months contract	-1.690***	(0.085)	-1.777***	(0.123)	-1.563***	(0.141)	-1.922***	(0.182)	-1.668***	(0.400)
Tariff with handset, 12 months contract	-4.340***	(0.065)	-4.385***	(0.093)	-4.149***	(0.109)	-4.416***	(0.132)	-4.104***	(0.345)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	6.710***	(0.082)	6.359***	(0.106)	6.378***	(0.129)	6.276***	(0.144)	11.379***	(0.445)
Dummy BlackBerry	2.906***	(0.068)	2.844***	(0.091)	2.899***	(0.112)	2.904***	(0.126)	6.276***	(0.393)
Dummy HTC	0.035	(0.108)	-0.144	(0.156)	0.196	(0.174)	-0.412	(0.240)	1.574**	(0.607)
Dummy LG	-0.076	(0.080)	-0.052	(0.110)	-0.111	(0.141)	-0.390*	(0.168)	1.137*	(0.454)
Dummy Motorola	0.015	(0.144)	-0.056	(0.203)	-0.095	(0.259)	-0.451	(0.348)	-12.273	(737.036)
Dummy Nokia	0.935***	(0.060)	0.868***	(0.082)	0.962***	(0.103)	0.775***	(0.115)	1.113**	(0.395)
Dummy Samsung	1.597***	(0.055)	1.565***	(0.075)	1.576***	(0.094)	1.528***	(0.104)	2.874***	(0.342)
Dummy smartphone=1	1.225***	(0.041)	1.261***	(0.056)	1.168***	(0.068)	1.252***	(0.078)	2.741***	(0.242)
Handset age (months)	-0.007***	(0.002)	-0.010***	(0.002)	-0.007**	(0.002)	-0.007**	(0.003)	0.005	(0.007)
Height	0.019***	(0.002)	0.017***	(0.003)	0.010**	(0.004)	0.025***	(0.004)	0.051***	(0.009)
Width	-0.011***	(0.003)	-0.021***	(0.005)	-0.017**	(0.006)	-0.032***	(0.006)	-0.097***	(0.017)
Thickness	0.040***	(0.008)	0.010	(0.011)	-0.008	(0.013)	0.001	(0.015)	-0.124**	(0.047)
Camera quality (MP)	0.099***	(0.006)	0.090***	(0.008)	0.095***	(0.010)	0.089***	(0.012)	0.312***	(0.022)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)	0.003***	(0.000)	0.003***	(0.001)
LTE × 4G tariff	1.221***	(0.082)	1.275***	(0.111)	1.259***	(0.133)	1.225***	(0.160)	1.230*	(0.519)
Residuals from handset price regression	0.005***	(0.000)	0.005***	(0.000)	0.005***	(0.000)	0.005***	(0.000)	0.015***	(0.001)
Residuals from tariff price regression	0.003*	(0.002)	0.004	(0.002)	0.004	(0.003)	0.002	(0.003)	0.013	(0.010)
Interactions of prices with time	Yes		Yes		Yes		Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes		Yes		Yes		Yes	
Observations	9,444,223		9,170,610		8,810,094		8,797,806		16,344,380	
Log likelihood	-3.95e+04		-2.23e+04		-1.57e+04		-1.22e+04		-1650.171	
Individuals	7,500		3,800		2,500		1,900		250	
CS Size (Average)	1291		2474		3617		4,756		69,068	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table reports estimation results obtained with alternative choice set constructions. Each column increases the number of randomly sampled tariffs and handsets included in each consumer's choice set, while reducing the number of consumers for computational feasibility. The column "20-20" reports results from a smaller sample in which each consumer's choice set includes 20 randomly sampled tariffs and 20 randomly sampled handsets. Similarly, the columns "40-40" and "60-60" use choice sets with 40 and 60 randomly sampled tariffs and handsets, respectively. The column "Full CS" reports results from a small sample of consumers facing all possible handset-tariff combinations available at the time of subscription. Because this specification is based on a very small sample, the full choice set results should be interpreted cautiously.

Figure OA.12: Attention weight γ obtained with larger choice sets



Notes: The figure plots estimates of γ from models estimated with alternative choice set constructions, as reported in Table OA.13.

Table OA.14: Determinants of consumers' choices with alternative choice sets (different sampling)

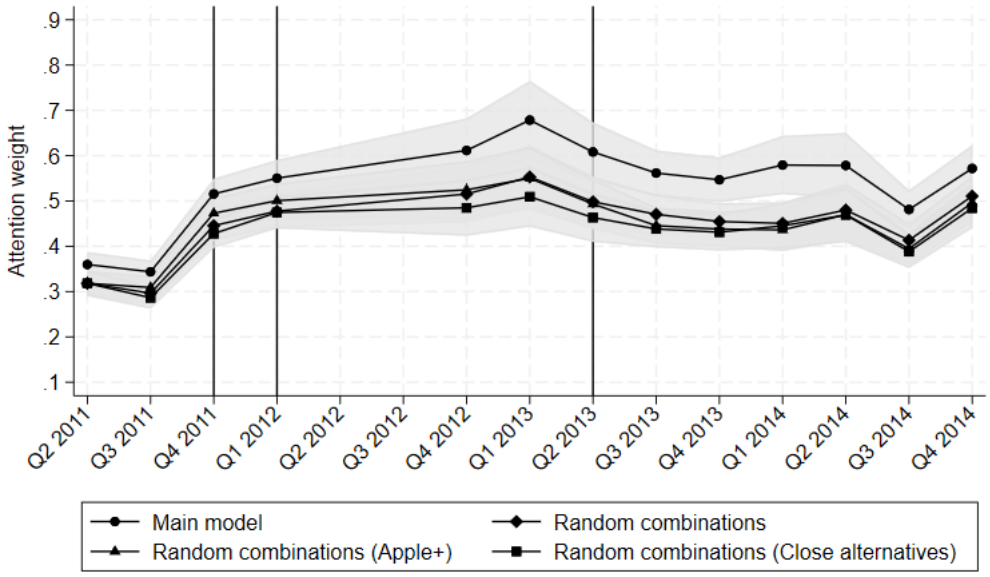
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)	
Estimation method: Conditional logit	Random combinations		Random combinations More Apple		Random combinations Close alternatives	
Upfront cost of handset	-0.007***	(0.000)	-0.007***	(0.000)	-0.008***	(0.000)
Present value of future costs	-0.002***	(0.000)	-0.002***	(0.000)	-0.002***	(0.000)
Data: 500 MB=1	1.140***	(0.029)	1.250***	(0.029)	1.383***	(0.030)
Data: 1 GB=1	1.481***	(0.047)	1.497***	(0.046)	1.820***	(0.048)
Data: 2 GB=1	1.360***	(0.054)	1.577***	(0.053)	2.112***	(0.054)
Data: 4 GB=1	1.504***	(0.055)	1.569***	(0.055)	1.299***	(0.062)
Data: 10 GB=1	2.215***	(0.112)	2.384***	(0.112)	2.143***	(0.116)
Unlimited calls=1	0.408***	(0.056)	0.477***	(0.055)	0.928***	(0.055)
Unlimited calls=0 × Allowance (minutes)	-0.002***	(0.000)	-0.002***	(0.000)	0.001***	(0.000)
Fixed broadband=1	1.706***	(0.047)	1.502***	(0.046)	1.516***	(0.048)
SIM-only no commitment	-0.405***	(0.042)	-0.394***	(0.042)	-0.429***	(0.043)
SIM-only 12 months contract	-2.362***	(0.057)	-2.367***	(0.056)	-2.364***	(0.057)
SIM-only, 24 months contract	-1.351***	(0.072)	-1.366***	(0.071)	-1.325***	(0.072)
Tariff with handset, 12 months contract	-3.903***	(0.051)	-3.927***	(0.051)	-3.910***	(0.051)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	6.664***	(0.070)	5.716***	(0.069)	6.882***	(0.071)
Dummy BlackBerry	3.341***	(0.062)	3.373***	(0.062)	3.449***	(0.063)
Dummy HTC	0.397***	(0.097)	0.391***	(0.097)	0.476***	(0.098)
Dummy LG	0.294***	(0.075)	0.266***	(0.075)	0.297***	(0.075)
Dummy Motorola	0.314*	(0.126)	0.360**	(0.126)	0.364**	(0.127)
Dummy Nokia	1.341***	(0.059)	1.332***	(0.058)	1.394***	(0.059)
Dummy Samsung	1.987***	(0.055)	1.987***	(0.055)	2.074***	(0.055)
Dummy Sony	1.573***	(0.081)	1.577***	(0.081)	1.733***	(0.081)
Dummy smartphone=1	1.162***	(0.033)	1.138***	(0.033)	1.190***	(0.033)
Handset age (months)	-0.012***	(0.001)	-0.012***	(0.001)	-0.010***	(0.001)
Height	0.017***	(0.002)	0.017***	(0.002)	0.018***	(0.002)
Width	-0.021***	(0.003)	-0.021***	(0.003)	-0.014***	(0.003)
Thickness	0.009	(0.007)	0.003	(0.006)	0.010	(0.007)
Camera quality (MP)	0.090***	(0.005)	0.087***	(0.005)	0.096***	(0.005)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)	0.002***	(0.000)
LTE × 4G tariff	1.256***	(0.065)	1.289***	(0.065)	1.291***	(0.066)
Residuals from handset price regression	0.005***	(0.000)	0.005***	(0.000)	0.005***	(0.000)
Residuals from tariff price regression	-0.018***	(0.001)	-0.015***	(0.001)	-0.018***	(0.001)
Interactions of prices with time	Yes		Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes		Yes	
Individuals	10,738		10,738		10,738	
Average number of alternatives	401		401		333	
Number of alternatives [Min - Max]	[401 - 401]		[401 - 401]		[128 - 561]	
Sampling methods	Random combinations		Random combinations with more iPhones		Random combinations (close alternatives)	
Observations	4,269,063		4,270,772		3,547,589	
Log likelihood	-4.42e+04		-4.62e+04		-4.20e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table re-estimates the main demand model using alternative choice set sampling rules. In the baseline specification, choice sets are constructed by randomly sampling tariffs and handsets separately and then forming all possible handset-tariff combinations from these draws. In this exercise, I instead sample handset-tariff combinations directly. The alternative sampling rules draw combinations either fully at random (Column 1), with higher sampling probability assigned to iPhone combinations (Column 2), or from alternatives close to the option actually chosen by the consumer (Column 3). In Column 3, the number of alternatives in the choice set varies across individuals because the number of close substitutes available in the market at the time of subscription differs across chosen alternatives. As a result, it is not always possible to reach the targeted number of sampled combinations.

Figure OA.13: Attention weight γ obtained with choice set built with alternative sampling



Notes: The figure compares estimates of γ under alternative rules for constructing the choice sets. The corresponding estimation results are reported in Table OA.14. "Apple+" denotes the specification in which Apple alternatives are sampled with higher probability, corresponding to Column 2 of the table.

Alternative approaches

Table OA.15: Fixed-Effects Approach

Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)		(4)	
Estimation method: Conditional logit	200 handset FEs		200 tariffs FEs		200 handset + 200 tariffs FEs		200 handset + 200 tariffs FEs + brand interactions	
Upfront cost of handset	-0.010***	(0.000)	-0.008***	(0.000)	-0.008***	(0.000)	-0.009***	(0.000)
Present value of future costs	-0.003***	(0.000)	-0.002***	(0.000)	-0.002***	(0.000)	-0.002***	(0.000)
Data: 500 MB=1	1.113***	(0.029)	0.316***	(0.081)	0.316***	(0.081)	0.325***	(0.081)
Data: 1 GB=1	1.667***	(0.048)	0.670***	(0.146)	0.670***	(0.146)	0.632***	(0.146)
Data: 2 GB=1	1.914***	(0.050)	0.308*	(0.143)	0.308*	(0.143)	0.287*	(0.144)
Data: 4 GB=1	1.676***	(0.057)	0.659***	(0.134)	0.659***	(0.134)	0.590***	(0.134)
Data: 10 GB=1	2.739***	(0.112)	1.366***	(0.250)	1.366***	(0.250)	1.134***	(0.253)
Unlimited calls=1	1.023***	(0.045)	0.676***	(0.138)	0.676***	(0.138)	0.588***	(0.139)
Unlimited calls=0 × Allowance (minutes)	0.001***	(0.000)	-0.002**	(0.001)	-0.002**	(0.001)	-0.003***	(0.001)
Fixed broadband=1	1.717***	(0.047)	0.672***	(0.115)	0.672***	(0.115)	0.622***	(0.116)
SIM-only no commitment	-0.380***	(0.045)	-1.724***	(0.203)	-1.724***	(0.203)	-1.265***	(0.205)
SIM-only 12 months contract	-2.564***	(0.057)	-0.917***	(0.115)	-0.917***	(0.115)	-0.463***	(0.120)
SIM-only, 24 months contract	-1.311***	(0.075)	-0.700***	(0.171)	-0.700***	(0.171)	-0.198	(0.174)
Tariff with handset, 12 months contract	-4.274***	(0.051)	-2.185***	(0.093)	-2.185***	(0.093)	-2.227***	(0.094)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	7.291***	(0.517)	6.310***	(0.074)	6.310***	(0.074)	7.005***	(0.602)
Dummy BlackBerry	1.536***	(0.322)	2.477***	(0.058)	2.477***	(0.058)	2.906***	(0.397)
Dummy HTC	0.788*	(0.358)	-0.166	(0.093)	-0.166	(0.093)	1.586***	(0.469)
Dummy LG	0.136	(0.295)	-0.173*	(0.069)	-0.173*	(0.069)	0.487	(0.376)
Dummy Motorola	0.139	(0.443)	-0.090	(0.125)	-0.090	(0.125)	1.160	(0.594)
Dummy Nokia	0.706*	(0.281)	0.986***	(0.051)	0.986***	(0.051)	0.907**	(0.337)
Dummy Samsung	0.351	(0.244)	1.542***	(0.046)	1.542***	(0.046)	0.377	(0.303)
Dummy smartphone=1	0.964***	(0.250)	1.227***	(0.037)	1.227***	(0.037)	0.749**	(0.255)
Handset age (months)	-0.026***	(0.006)	0.012***	(0.001)	0.012***	(0.001)	-0.025***	(0.006)
Height	0.006	(0.009)	0.018***	(0.002)	0.018***	(0.002)	0.003	(0.010)
Width	-0.014	(0.018)	0.007*	(0.003)	0.007*	(0.003)	-0.008	(0.017)
Thickness	0.000	(0.047)	0.047***	(0.007)	0.047***	(0.007)	-0.016	(0.047)
Camera quality (MP)	0.145***	(0.027)	0.076***	(0.006)	0.076***	(0.006)	0.146***	(0.026)
Battery standby time (hours)	-0.001	(0.001)	0.002***	(0.000)	0.002***	(0.000)	-0.001	(0.001)
LTE × 4G tariff	1.631***	(0.089)	1.577***	(0.078)	1.577***	(0.078)	1.845***	(0.101)
Interactions of prices with time	Yes		Yes		Yes		Yes	
Interactions of prices with age groups and gender	Yes		Yes		Yes		Yes	
200 handset FEs	Yes		No		Yes		Yes	
200 tariffs FEs	No		Yes		Yes		Yes	
Dummy Apple=1 × Quarter							0.027	(0.026)
Dummy BlackBerry=1 × Quarter							-0.155***	(0.024)
Dummy HTC=1 × Quarter							-0.100**	(0.038)
Dummy LG=1 × Quarter							-0.039	(0.031)
Dummy Motorola=1 × Quarter							-0.169*	(0.082)
Dummy Nokia=1 × Quarter							-0.027	(0.021)
Dummy Samsung=1 × Quarter							0.004	(0.020)
Observations	3,851,776		3,851,776		3,851,776		3,851,776	
Log Likelihood	-3.83e+04		-3.88e+04		-3.88e+04		-3.26e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table reports specifications that replace the control-function approach used in Table A.1 with product fixed effects for the most frequently selected handsets and/or tariffs. The residuals from the first stage price regressions are therefore not included. In all specifications, the coefficients on upfront handset costs and the present value of future recurring costs are interacted with subscription quarter, age group, and gender. Fixed effects are included for the 200 most frequently selected products. The 200 handset fixed effects cover 69.8% of chosen handsets over the full sample period, corresponding to 63.7% of handset models. The 200 tariff fixed effects cover 64.16% of chosen tariffs, corresponding to 33.5% of available tariffs.

Table OA.16: Fixed-Effects + Control Function Approach

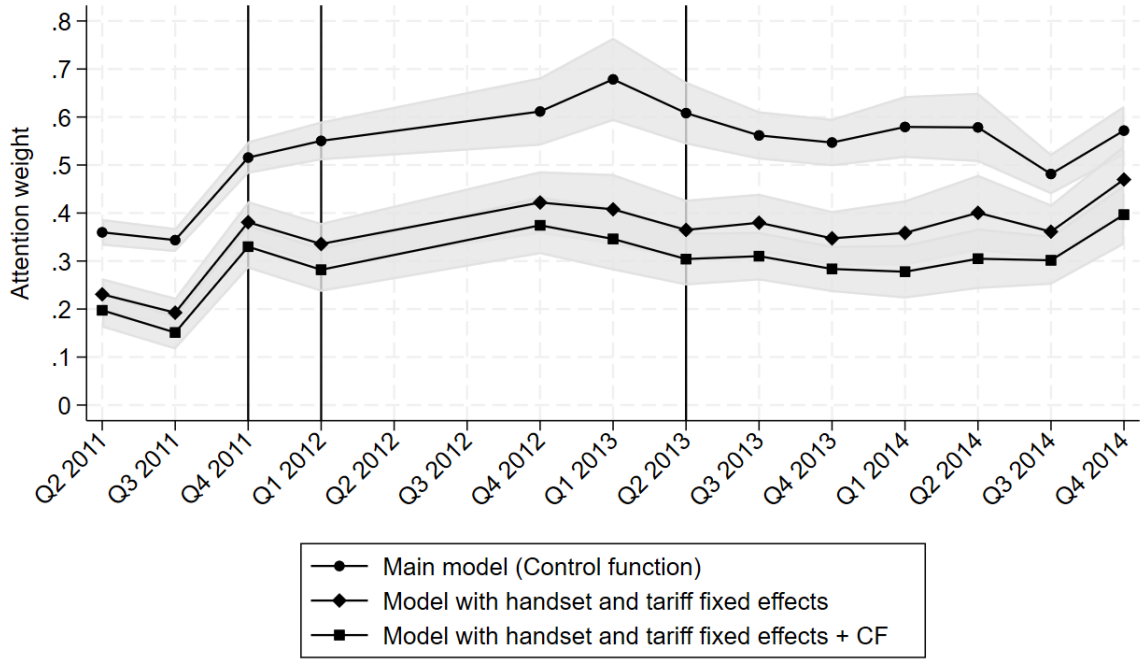
Dependent variable: Alternative is chosen (0/1)	(1)		(2)		(3)	
Estimation method: Conditional logit	Main Model (CF)		FEs		FEs + CF	
Upfront cost of handset	-0.009***	(0.000)	-0.009***	(0.000)	-0.009***	(0.000)
Present value of future costs	-0.003***	(0.000)	-0.002***	(0.000)	-0.002***	(0.000)
Data: 500 MB=1	1.142***	(0.030)	0.325***	(0.081)	0.243**	(0.082)
Data: 1 GB=1	1.727***	(0.049)	0.632***	(0.146)	0.531***	(0.147)
Data: 2 GB=1	2.012***	(0.055)	0.287*	(0.144)	0.056	(0.152)
Data: 4 GB=1	1.878***	(0.067)	0.590***	(0.134)	0.297*	(0.146)
Data: 10 GB=1	3.046***	(0.127)	1.134***	(0.253)	0.621*	(0.270)
Unlimited calls=1	1.226***	(0.060)	0.588***	(0.139)	0.314*	(0.149)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	-0.003***	(0.001)	-0.004***	(0.001)
Fixed broadband = 1	1.813***	(0.050)	0.622***	(0.116)	0.567***	(0.119)
SIM-only no commitment	-0.718***	(0.045)	-1.265***	(0.205)	-1.118***	(0.206)
SIM-only 12 months contract	-2.907***	(0.062)	-0.463***	(0.120)	-0.160	(0.128)
SIM-only, 24 months contract	-1.739***	(0.073)	-0.198	(0.174)	0.008	(0.177)
Tariff with handset, 12 months contract	-4.345***	(0.055)	-2.227***	(0.094)	-2.105***	(0.101)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)	0.000	(.)
Dummy Apple	6.864***	(0.075)	7.005***	(0.602)	5.966***	(0.610)
Dummy BlackBerry	2.897***	(0.060)	2.906***	(0.397)	3.420***	(0.409)
Dummy HTC	0.038	(0.094)	1.586***	(0.469)	1.916***	(0.469)
Dummy LG	-0.110	(0.070)	0.487	(0.376)	0.792*	(0.388)
Dummy Motorola	-0.053	(0.126)	1.160	(0.594)	1.416*	(0.595)
Dummy Nokia	1.013***	(0.051)	0.907**	(0.337)	0.936**	(0.350)
Dummy Samsung	1.643***	(0.047)	0.377	(0.303)	0.497	(0.309)
Dummy smartphone=1	1.241***	(0.037)	0.749**	(0.255)	0.708**	(0.259)
Month since handset release	-0.007***	(0.001)	-0.025***	(0.006)	-0.040***	(0.006)
Height	0.019***	(0.002)	0.003	(0.010)	0.002	(0.009)
Width	-0.006*	(0.003)	-0.008	(0.017)	-0.017	(0.016)
Thickness	0.059***	(0.007)	-0.016	(0.047)	-0.036	(0.048)
Camera quality (MP)	0.102***	(0.006)	0.146***	(0.026)	0.188***	(0.022)
Battery standby time (hours)	0.002***	(0.000)	-0.001	(0.001)	-0.000	(0.001)
LTE × 4G tariff	1.259***	(0.070)	1.845***	(0.101)	1.834***	(0.103)
Residuals from handset price regression	0.006***	(0.000)			0.008***	(0.000)
Residuals from tariff price regression	0.006***	(0.001)			-0.012***	(0.003)
Handset FEs	No		Yes		Yes	
Tariff FEs	No		Yes		Yes	
Brand-time trends	No		Yes		Yes	
Observations	3,851,776		3,851,776		3,851,776	
Log Likelihood	-4.42e+04		-3.26e+04		-3.24e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table compares the preferred control-function (CF) specification, the product fixed-effects specification, and a specification that combines both approaches. Product fixed effects are included for the 200 most frequently selected handsets and/or tariffs. Column 1 corresponds to Model IV in Table A.1. Column 2 corresponds to the fourth specification in Table OA.15.

Figure OA.14: Attention weight γ under control-function and product fixed-effects specifications



Notes: The figure reports the evolution γ based on the estimates from the specifications presented in Table OA.16. It compares the preferred control-function specification with alternatives that include product fixed effects for the most frequently selected handsets and tariffs.

Table OA.17: Determinants of consumers' choices with random price coefficients

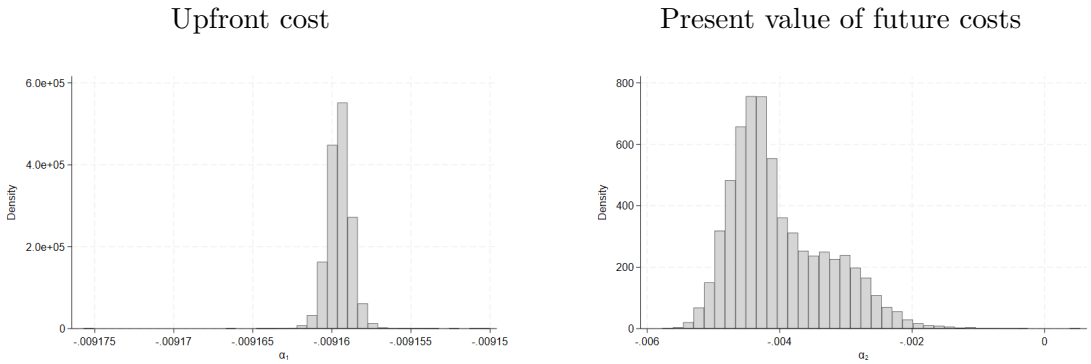
Dependent variable: Alternative is chosen (0/1)	(1)		(2)	
Estimation method: Conditional logit and mixed logit	Clogit		Mixlogit	
Main				
Upfront cost of handset	-0.009***	(0.000)	-0.009***	(0.000)
Present value of future costs	-0.003***	(0.000)	-0.004***	(0.000)
Data: 500 MB=1	1.142***	(0.030)	1.252***	(0.031)
Data: 1 GB=1	1.727***	(0.049)	1.862***	(0.052)
Data: 2 GB=1	2.012***	(0.055)	2.269***	(0.059)
Data: 4 GB=1	1.878***	(0.067)	2.086***	(0.071)
Data: 10 GB=1	3.046***	(0.127)	3.350***	(0.134)
Unlimited calls=1	1.226***	(0.060)	1.452***	(0.064)
Unlimited calls=0 × Allowance (minutes)	0.002***	(0.000)	0.003***	(0.000)
Fixed broadband=1	1.813***	(0.050)	2.055***	(0.054)
SIM-only, no commitment	-0.718***	(0.045)	-0.882***	(0.048)
SIM-only, 12 months contract	-2.907***	(0.062)	-3.156***	(0.065)
SIM-only, 24 months contract	-1.739***	(0.073)	-1.804***	(0.073)
Tariff with handset, 12 months contract	-4.345***	(0.055)	-4.531***	(0.056)
Tariff with handset, 24 months contract	0.000	(.)	0.000	(.)
Dummy Apple	6.864***	(0.075)	6.979***	(0.077)
Dummy BlackBerry	2.897***	(0.060)	2.934***	(0.060)
Dummy HTC	0.038	(0.094)	0.055	(0.095)
Dummy LG	-0.110	(0.070)	-0.108	(0.070)
Dummy Motorola	-0.053	(0.126)	-0.040	(0.126)
Dummy Nokia	1.013***	(0.051)	1.020***	(0.051)
Dummy Samsung	1.643***	(0.047)	1.661***	(0.047)
Dummy smartphone=1	1.241***	(0.037)	1.274***	(0.037)
Handset age (months)	-0.007***	(0.001)	-0.007***	(0.001)
Height	0.019***	(0.002)	0.020***	(0.002)
Width	-0.006*	(0.003)	-0.005	(0.003)
Thickness	0.059***	(0.007)	0.062***	(0.007)
Camera quality (MP)	0.102***	(0.006)	0.106***	(0.006)
Battery standby time (hours)	0.002***	(0.000)	0.002***	(0.000)
LTE × 4G tariff	1.259***	(0.070)	1.350***	(0.072)
Residuals from handset price regression	0.006***	(0.000)	0.006***	(0.000)
Residuals from tariff price regression	0.006***	(0.001)	0.009***	(0.001)
Interactions of prices with time, age groups, and gender.	Yes		Yes	
Standard deviations				
Present value of future costs			0.002***	(0.000)
Upfront cost of handset			0.000	(0.000)
Observations	3,851,776		3,851,776	
Log likelihood	-4.42e+04		-4.41e+04	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

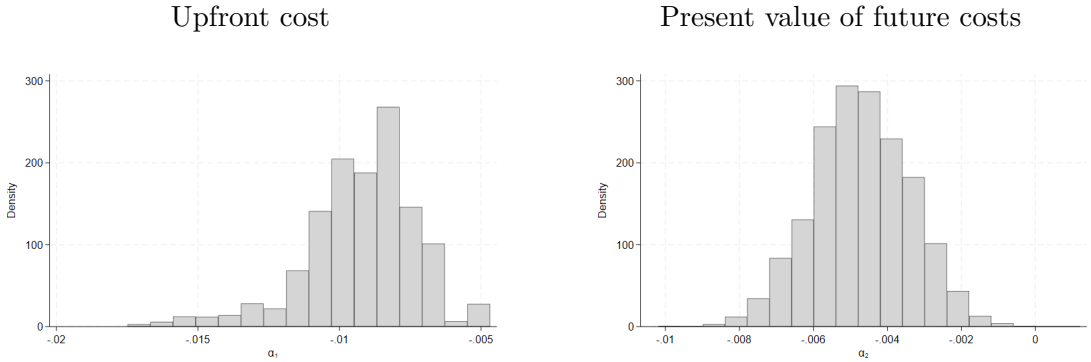
Notes: The table compares the preferred conditional logit specification with a mixed logit model that allows random coefficients on the upfront handset cost and the present value of future recurring costs. This relaxes the baseline logit substitution pattern along the dimensions that determine the attention weight. The mixed logit specification allows the selected coefficients to vary across consumers. Coefficients reported under "Mean" are the estimated population mean effects, while coefficients reported under "Standard deviations" are the estimated standard deviations of the corresponding random coefficients and therefore capture preference heterogeneity. Model 1 corresponds to Model IV in Table A.1.

Figure OA.15: Distribution of estimated random price coefficients



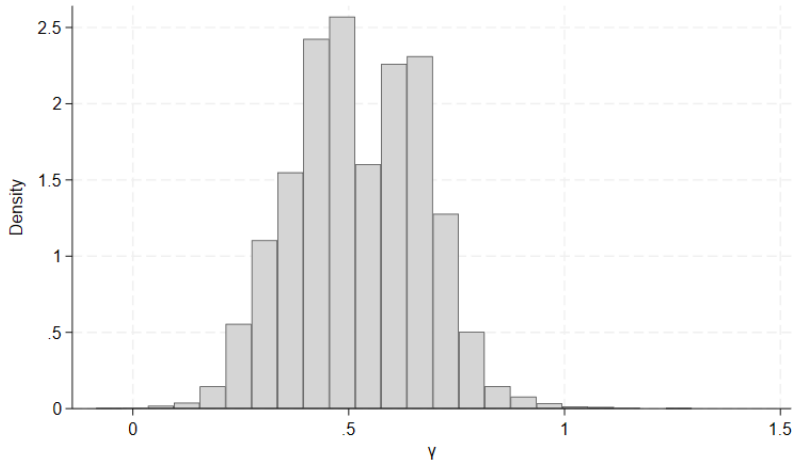
Notes: The figure reports the distribution of the price coefficients estimated in the mixed logit model presented in Table OA.17. These distributions are shown before adding interactions with subscription quarter, age group, and gender; they therefore correspond to the base group, defined as consumers aged 45-54 subscribing in Q2 2011.

Figure OA.16: Distribution of mixed logit price coefficients with observed heterogeneity



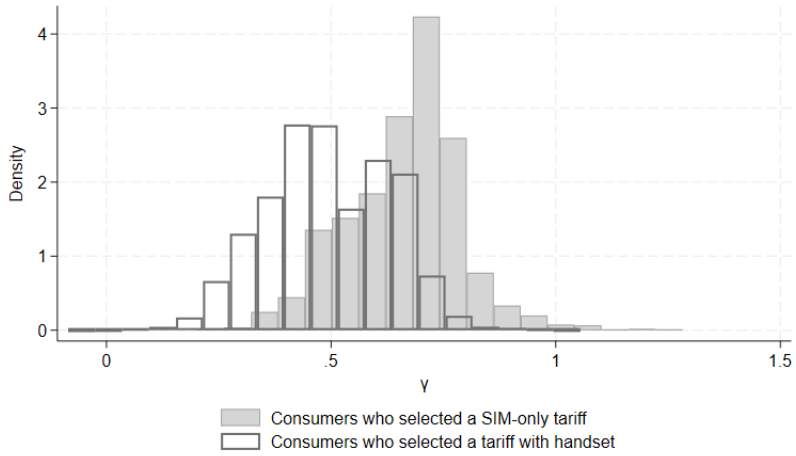
Notes: The figure reports the distribution of individual-level price coefficients from the mixed logit specification. The coefficients combine the random coefficients shown in Figure OA.15 with the estimated interactions with subscription quarter, age group, and gender. The resulting distributions are computed for the 10,738 consumers in the estimation sample, based on their observed characteristics and subscription timing.

Figure OA.17: Distribution of attention weight (γ) computed with random coefficients



Notes: The figure reports the distribution of γ implied by the mixed logit model presented in Table OA.17. The attention weight is computed for the 10,738 consumers in the estimation sample using the individual-level price coefficients reported in Figure OA.16.

Figure OA.18: Distribution of attention weights (γ) computed with random coefficients, by tariff type



Notes: The figure compares the distribution of the attention weight γ across consumers who selected SIM-only tariffs and consumers who selected tariffs bundled with a handset. Values are computed from the mixed logit specification in Table OA.17, using the individual-level price coefficients.